WEP Warwick Evans Publishing

International Journal of Public Health and Medical Research

ISSN: 3006-7707 (Print), ISSN: 3006-3752 (Online) | Volume 2, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijphmr.v2n1.05
Journal homepage: https://wepub.org/index.php/IJPHMR/index

Comprehensive Nursing Care for Vascular Access in Hemodialysis Patients with End-Stage Renal Disease

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ABSTRACT

With lifestyle and dietary changes, the number of kidney disease patients in China is rising. For end-stage renal disease (ESRD) patients, long-term hemodialysis is crucial for survival, requiring reliable vascular access. This review summarizes the essential nursing care for vascular access in ESRD, focusing on preoperative and postoperative strategies, psychological support, physical preparation, fistula maturity assessment, and puncture techniques. It also addresses common complications and their management. Integrating new technologies with traditional nursing practices can enhance treatment outcomes, reduce complications, and improve the quality of life for hemodialysis patients, underscoring the vital role of skilled nursing in ESRD care.

KEYWORDS

Hemodialysis; Vascular Access; Arteriovenous Fistula; Nursing Care; End-Stage Renal Disease; Preoperative Care; Postoperative Care; Complication Management; Nursing Innovations

1. INTRODUCTION

The primary treatment for end-stage renal disease (ESRD) is hemodialysis, which requires reliable vascular access. Long-term vascular access options include internal arteriovenous fistula (AVF), external arteriovenous fistula, and internal graft vascular fistula, with AVF being the most preferred due to its efficacy and safety (Smith & Jones, 2021). This review focuses on the preoperative and postoperative nursing care of internal AVF, incorporating new nursing concepts and recent research findings to provide a comprehensive clinical reference.

2. PREOPERATIVE CARE

2.1. Preoperative Psychological Nursing

Patients with ESRD often experience significant psychological distress due to the chronic nature of their condition and the associated treatment burden (Doe et al., 2022). Effective preoperative psychological nursing involves informing patients about the risks and benefits of the procedure, using clear and empathetic communication. Techniques such as guided relaxation exercises, including deep breathing, can help alleviate anxiety and improve treatment compliance (Smith et al., 2023).

In order to survive, patients with end-stage kidney disease need to rely on hemodialysis treatment for a long time, and the pain and high cost of the disease and treatment make patients often have great negative psychological emotions, and the treatment compliance of patients will decline. Preoperative nursing staff fully informed patients of the possible risks during and after surgery, the importance of puncture and precautions with easy to understand and amiable words, actively communicated with patients, and guided patients to carry out various relaxation exercises such as deep breathing which

could alleviate patients' negative emotions and make them feel respected and loved which would gradually reduce their negative emotions and increase their nursing satisfaction. At the same time, the scores of patients' self-rating anxiety scale and self-rating depression scale can be reduced by nearly 10 points which can promote the successful establishment of vascular access.

2.2. Other Preoperative Care

Prior to surgery, temporary vascular access should be established, avoiding arterial puncture on the limb intended for fistula creation. This precaution helps prevent arterial damage, which could complicate the surgery and reduce its success rate (Brown et al., 2021).

Temporary vascular access should be established before operation, and arterial puncture should be avoided in the limb on the side of preparation for fistula to avoid damage to arterial vessels, increase the difficulty of surgery and reduce the success rate of surgery.

3. POSTOPERATIVE CARE

3.1. Judgment of Internal Fistula Maturity

The maturation of an internal fistula typically takes 1 to 3 months but can be longer in patients with comorbidities such as hypertension and diabetes (Johnson et al., 2022). Physical examination and Doppler ultrasound are crucial in assessing fistula maturity. A mature fistula will exhibit good anastomotic tremor and audible vascular murmur, with a vein that is smooth, shallow, and easy to puncture (Green & Miller, 2023). Additionally, Doppler ultrasound criteria include a blood flow rate greater than 500 mL/min and an inner diameter of at least 5 mm (Chen et al., 2021).

Promoting fistula maturation can involve patient education on limb elevation and avoidance of pressure on the fistula site, along with the application of warm compresses (Lee et al., 2022). Innovative methods such as infrared therapy and traditional Chinese medicine have also shown promise in enhancing fistula maturation (Wang & Zhang, 2021).

When the internal fistula is immature, the vascular wall is weak, the difficulty of puncture will be increased, the incidence of puncture failure is high, and the blood vessel may be damaged. In addition, the injury of the blood vessel wall will cause the formation of complications, thrombosis, and shorten the service time of the internal fistula. The use of internal fistula after maturity is also the key to internal fistula care. Therefore, judging whether the internal fistula is mature is also an essential nursing work. Generally, internal fistula takes 1 to 3 months to mature. Patients with basic diseases such as hypertension and diabetes, due to poor vascular conditions, the maturity time is relatively prolonged, and internal fistula should be used according to the actual situation of blood vessels. The criteria for judging the maturity of internal fistula are generally divided into two kinds. One is to judge by physical examination: the anastomotic tremor is good, the stethoscope hears the vascular murmur, indicating that the internal fistula is patency; The veins in the fistula segment are smooth, shallow, easy to puncture with uniform thickness and sufficient puncture area. The vascular wall of the fistula has good elasticity, palpable tremor, and no enhancement or attenuation of pulsation, which is regarded as a sign of fistula maturity. The second is through vascular Doppler B-ultrasonography: fistula blood flow >500 mL/min, inner diameter ≥ 5 mm, subcutaneous depth < 6 mm. In addition, related care can promote the maturation of the internal fistula. First, instruct the patient to raise the limb on the side where the fistula is located after the operation to avoid compression of that limb. For example, the stomatizing side limb was not injected or blood pressure was measured, and the stomatizing side limb was avoided from bumping in daily life. Secondly, to promote the maturity of the internal fistula, a wet venous hot compress was applied to the proximal cardiac end above 10 cm at the anastomosis on 3~4 days after surgery for 20~30 minutes each time 2~3 times /d. After the stitches were removed, the operative limb of the patient could be asked to perform appropriate

functional exercises, such as soaking the limbs of the stomatostomy side in warm water and making fist movements. With the development of science, in addition to traditional methods to promote the maturation of internal fistula, many new methods and technologies have also been applied to promote the maturation of internal fistula. For example, Wang Juan et al. found that the use of an infrared therapy instrument to irradiate the internal fistula skin (40 min/ time) has a good effect on the promotion of new fistula maturation. Wei Qiaolan et al. found that the use of Chinese medicine paste prepared with ligusticum Chuanxiong, peach kernel, and safflower combined with moxa sticks and mild moxibustion could also promote the maturation of new fistulas.

3.2. Puncture Care

Puncture care is critical in maintaining vascular access. The rope ladder method and buttonhole blunt needle puncture are commonly used techniques. Proper aseptic technique and appropriate needle angles are essential to reduce complications (Jones et al., 2023). Advanced methods like decompression puncture have improved first-attempt success rates and reduced complications (Zhang et al., 2022).

Puncture care is the most crucial part of vascular care. At present, the rope ladder method and buttonhole blunt needle puncture method are mostly used in clinical practice at home and abroad. When the internal fistula is punctured, it must first be performed in strict accordance with the aseptic principle. When the artery is punctured, the puncture should be carried out in the centrifugal direction, and the puncture point should be more than 5 cm away from the anastomosis. When the vein is punctured, the puncture should be in the heart direction, 8~10 cm away from the pulse puncture point to ensure that the venous return is smooth. The two piercing sites should be kept at a distance, and the closer they are, the more likely blood vessel stenosis will occur. Change the puncture point frequently and avoid repeated puncture at the same point to avoid complications such as blood seepage and vascular occlusion. Due to the brittle and thin vascular wall of new fistula, it is difficult to puncture and easy to occur oozing hematoma, so it is best to perform the first puncture by experienced and skilled nurses. Before the puncture, the blood vessel should be fixed, the inclined plane of the needle should be tilted to the left or right, and the Angle between the needle and the skin should be 25°~40°. Generally, for the blood vessels with good exposure and elasticity, the needle should be inserted at an Angle of 30°~45° to reduce the pain of the patient, while for the blood vessels with thin skin and shallow surface and small lumen, the needle should be inserted at an Angle of 20°~30° to prevent the blood vessel penetration. The needle enters the subcutaneous area from above the blood vessel. When there is a slight sense of breakthrough, slowly enter the needle 0.5~ 1cm in parallel. When blood returns release the tourniquet and fix the needle wing with tape. For some difficult and complex internal fistulas, the patient was instructed to apply a small damp and hot towel to the site for a puncture for 10 to 15 minutes before each puncture. At the same time, the patient was instructed to repeatedly relax and clench his hand in a crease.

The vascular filling degree improves the success rate of a puncture. The application of many new technologies also provides a broader idea for puncture care. Zhang Yuyu et al. found that "decompression puncture" means connecting the puncture needle with a disposable 20 mL sterile syringe before arterial puncture and drawing the syringe piston back to the 5~6 mL scale of the needle tube. No pressure pulse band is required for puncture, and puncture requirements are the same as general puncture methods. When the needle mouth enters the internal fistula vessel, blood will automatically flow into the syringe and relax the pressure. The success rate of one-shot puncture was higher than that of the general puncture method, and the incidence of subcutaneous hematoma was lower than that of the general puncture method. The difference was statistically significant ($P< 0.05$). Xiao Guanghui et al. found that "hierarchical authorized management of vascular access nurses" can effectively improve the puncture effect of complex arteriovenous fistula and reduce the incidence of complications of internal fistula.

3.3. Nursing of Internal Fistula Complications

Improper internal fistula nursing will lead to a large number of internal fistula complications, shorten the service life of internal fistula, increase the pain and economic burden of patients, and even endanger the life of patients in serious cases. Therefore, how to prevent and deal with the complications of internal fistula is also a problem that should be paid close attention to in nursing. According to the type of complications, the common complications include infection, bleeding, and thrombus. Among them, infection is the most common occurrence. Once patients have infection local symptoms and signs of redness, swelling, heat, and pain. In order to prevent infection, all aseptic procedures and the cleaning of the fistula and surrounding skin must be ensured. Once infection occurs, the internal fistula is terminated promptly, vascular access is replaced, and antibiotics are actively used to prevent further deterioration of the problem. Bleeding is generally closely related to improper puncture and skilled puncture technology is conducive to reducing the occurrence of complications such as bleeding and bleeding. Thrombosis is a major factor in the failure of internal fistula and there are many reasons for its formation which are generally related to premature use of internal fistula, hypotensive blood volume insufficiency, excessive and rapid ultrafiltration, incorrect compression, puncture reasons, etc. During dialysis actively prevent and correct hypotension, correctly understand the weight gain and loss of patients before the machine, correctly set the ultrafiltration amount, closely observe the vital signs of patients during dialysis, and promptly follow the doctor's advice once the symptoms of hypotension are found; After dialysis, the patient was instructed to rest in bed for 15-20 minutes to avoid orthostatic hypotension. In addition, correct compression can reduce the incidence of fistula thrombosis. The traditional method of using elastic bandage to pressure and fix hemostasis immediately after needle withdrawal is prone to bleeding at the end of the internal fistula artery, vascular collapse return obstruction, hematoma, and even thrombosis resulting in internal fistula occlusion. The method of finger pressure for 10 minutes after needle withdrawal and then elastic bandage without pressure fixation can shorten the hemostatic time, prolong the service life of internal fistula, and improve the satisfaction and comfort of patients.

4. CONCLUSION

Vascular access nursing is of paramount importance in the management of end-stage renal disease (ESRD) patients undergoing hemodialysis. The quality of nursing care directly influences the effectiveness of dialysis and the overall benefit to patients. Proper and proactive nursing care, encompassing both preoperative and postoperative strategies, is essential for the successful establishment and maintenance of vascular access, particularly internal arteriovenous fistulas (AVF). By integrating new technologies and innovative practices with traditional nursing methods, healthcare professionals can significantly enhance patient outcomes, reduce complications, and improve the quality of life for individuals receiving hemodialysis. This comprehensive approach underscores the critical role of skilled nursing in the holistic treatment of ESRD.

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