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Nursing Techniques for Permanent Vascular Access Puncture

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Abstract: Permanent vascular access is the lifeline of dialysis patients. The best vascular access puncture nursing technology not only affects the anxiety of dialysis patients about puncture technology and their willingness to continue dialysis, but also extends their life expectancy through daily vascular care, which can also enable dialysis patients to obtain good dialysis and quality of life. Appropriate puncture techniques require careful evaluation of the patient's vascular access status, needs, and nursing personnel who assist in the first puncture. In addition, dialysis nursing personnel with professional experience should continue to improve puncture techniques and re-educate and monitor the function and presence of infection signs at the puncture site for a long time.

1. Introduction

Some end-stage renal patients need to receive hemodialysis treatment [1]. The so-called lifeline refers to permanent vascular access as the only way for end-stage renal patients to receive hemodialysis treatment; In the face of China's increasing dialysis population year by year, good vascular access care can not only provide appropriate dialysis quality, but also reduce the rate of repeated hospitalization of patients and reduce health insurance medical expenses [2]. In addition, the puncture technology of vascular access also indirectly affects the appropriate dialysis efficiency, the psychological feelings of patients, and their willingness to continue receiving dialysis [3].

2. Assessment of Vascular Access before Puncture

Routine evaluation and examination of vascular access is aimed at early detection of vascular access problems, improving the success rate of puncture techniques, and extending the service life of vascular access. Currently, the examination methods for vascular access can be divided into physical examination and imaging examination, including Doppler ultrasound and angiography. In clinical application, the most basic physical examination should include visual examination, palpation, and auscultation. When you gently touch the vascular pathway with your fingers, you will feel pulsation, and there will be a continuous and stable sense of tremor during palpation (Thrill), auscultation of blood flow sounds is strong and powerful; In addition, when the arm is

raised, the venous flow in the limb is smooth, and when the pulse enhancement test presses the proximal end of the arteriovenous fistula (AVF), the AVF will bulge.

Imaging examination can help to measure the size of blood flow through vascular pathways, among which the most common is ultrasound examination. The indicators of good AVF in ultrasound examination are: diameter at least 4 mm, blood flow at least 500 mL/min, and depth less than 5 mm [4].However, ultrasound depends on the operator's experience. If you are not familiar with dialysis vascular access, it may lead to inaccurate detection of vascular access. Angiography is an invasive examination that requires injection of developer and radiation to develop the site. It can be used as a method to identify vascular lesions and require interventional treatment, and plays an important role in the treatment of vascular dysfunction. It is important for professional dialysis nursing personnel to familiarize themselves with the basic physical examination techniques of blood vessels and apply them to daily clinical techniques before puncturing blood vessels [5].

A good hemodialysis pipeline should cover the following conditions [6]. First, two channels (A-end and V-end) can be used for dialysis with good clearance rate. The blood flow velocity should be at least 300 mL/min. There is only a very low incidence of infection and thrombosis. Early referral of patients is important for the maturation of vascular pathways. Among the types of vascular access, arteriovenous fistulas (AVF) are the least likely to require postoperative recanalization compared to artificial blood vessels (AVG) and central venous catheters (CVC), making them the first choice for hemodialysis access. Currently, the accepted principle is to select the non habitual side and establish AVF for the blood vessel farthest from the limb.

Early referral of patients for blood access can enable AVF to mature as early as possible, avoid using CVC as a conduit for initial dialysis, and may even delay the progression of end-stage renal disease. In addition, for diabetes and elderly patients, referral to the nephrology department for regular tracking one year before dialysis is beneficial to the first year survival rate of dialysis [7]. There are three predictors of eventual unavailability of AVF: the patient's own cardiovascular disease, the use of CVC for first dialysis, and the use of fistulas without sufficient maturity. The third reason has the greatest impact [8]. Therefore, the timing of referral is very important. The National Kidney Foundation Kidney Disease Outputs Quality Initiative. NKF KDOQI recommends explaining various dialysis methods, advantages and disadvantages of access. At the beginning of this period, it is also important to avoid drawing blood or placing intravenous drip catheters when evaluating the appropriate portion of the forearm for the patient. The physician should record whether the patient has diabetes, heart failure, any malignant disease, systemic disease that may lead to shortened life expectancy, disease that may affect blood coagulation function, whether there has been any surgery that affects the dialysis vessels or has placed catheters before, and which side is the preferred hand. The physical examination that should be performed includes edema, Allen test, and any signs of heart failure. To assess the vascular condition, observe the vascular perfusion using a tourniquet or use Doppler ultrasound [9].There is no unified international guideline for the timing of establishing dialysis pipelines [10]. It is generally believed that it is necessary to consider the rate of decline in the filtration rate of renal fibroids in patients, their own diseases, and the severity of uremia. Considering that it is not easy for diabetes patients to mature their vascular pathways and the filtration rate of renal glomeruli drops rapidly, it is generally recommended that sugar dialysis pipelines are established in patients with urinary diseases at a high glomerular filtration rate.

3. Puncture Technology

3.1. Selection of Puncture Needle

Selecting a suitable puncture needle is important for hemodialysis clearance efficiency. Based on the required blood pumping speed and the appropriate blood flow rate in the vascular pathway, the

nursing personnel performing the puncture use visual and tactile examinations to select the appropriate diameter of the fistula to determine the most appropriate puncture needle specification [11]. When a tourniquet is not used, the size of the puncture needle should be equal to or smaller than the size of the vein, and should match the blood flow rate. Usually, the smallest puncture needle (17G) is used for the first attempt of puncture. If the arterial pressure is below 200 to 250 mmHg and the venous pressure is above 250 mmHg, a larger needle should be replaced.

Arterial needles will have a back hole (oval opening at the back of the needle) to optimize the flow of blood within the artery and reduce the need for needle rotation and turnover. In addition, the selection of puncture methods for sharp and blunt needles is related to the selection of different puncture techniques such as rope ladder and button hole cannulation, as well as to complications such as leakage, exudation, and crusting [12].

3.2. Ultrasound Assisted Puncture

Using ultrasound guided AVF puncture can improve the puncture rate of difficult needle insertion, and also reduce the time required to start hemodialysis and the occurrence of local complications at the puncture site. However, it still needs to be confirmed by randomized controlled trials on ultrasound guided puncture and non assisted puncture [13]. Continuous education and training of dialysis nursing personnel on puncture techniques and theoretical knowledge, especially for the newly established AVF puncture, is necessary [14]. Most patients with newly established artificial blood vessels (AVG) will experience significant tissue swelling due to tunneling. At this time, palpation is difficult, usually at least 2 weeks after surgery, and only after the swelling subsides can palpation be performed along the direction of the AVG. The timing of early AVG puncture should also be at least 24 hours after placement, and only when the swelling subsides and AVG is palpated can the puncture be performed [15].

3.3. Puncture Methods for Vascular Access

There are three main types of technology: area technology, rope ladder technology, and buttonhole technology.

3.3.1. Regional Technology

Repeated puncture in the same area of the vascular pathway will expand the aneurysm that is prone to form the puncture area, and subsequently narrow the adjacent area. The overlying skin will become thinner and take longer to stop bleeding. Currently, this technique is no longer recommended [11].

3.3.2. Rope Ladder Technology

It refers to using the entire length of the blood vessel that can be punctured for puncture. During each dialysis process, there will be two newly established puncture sites. The distance between the tip of the arterial needle and the venous needle is about 5 cm, and the distance from the anastomosis of the arterial and venous vessels is at least 3 cm. It is also necessary to avoid the previous puncture site, which mainly causes moderate expansion of the blood vessels on the venous segment. The placement direction of the venous needle is along the blood flow direction (antegrade), while the placement direction of the arterial needle can be along the blood flow direction or against the blood flow direction (retrograde). The position of the needle bevel and the reversal of the needle are still controversial, and upwardly and downwardly inclined punctures can be accepted until further research demonstrates the risks and benefits [2]. Generally, the puncture angle of AVF is 25 °, and

the puncture angle of AVG is 45 °. AVG is more tenacious than autologous AVF, and autologous AVF is more common in puncture related complications [16]. Past studies suggest that rope ladder techniques should be used for AVG puncture to avoid AVG dissociation and the formation of pseudoaneurysm [15].

3.3.3. Button Eyelet Technology

This puncture technique is fixed site puncture and is not suitable for AVG. Due to the need to repeat the puncture at the same location and use the same puncture angle and depth, the professional experience and skills of nursing personnel are even more required. After approximately 6-10 punctures, the tissue tunnel will be formed through sharp needles to allow for puncture using blunt needles, and the puncture site should be carefully selected in areas without aneurysms, leaving at least 5 cm between the needle tips. Ideally, a fistula puncture should be performed by the same caregiver until the vascular channel is established to reduce the risk of deformities. Observational studies have shown that this puncture technique has the benefits of reducing the incidence of complications: low invasion, reducing the incidence of hematoma, reducing the incidence of aneurysm, improving hemostasis time, and reducing puncture pain [11]. There are also studies that suggest that this technology can help patients easily puncture themselves and extend the life expectancy of AVF [17]. Other studies have shown that patients undergoing button-eye puncture increase the risk of infection, ranging from mild skin infections at vascular access sites to bacteremia or septicemia, while re education of nursing staff on cleaning and scab removal techniques can reduce the infection rate [11]. Correct placement of the puncture needle exposes approximately 2 mm, which can prevent the formation of large crusts at the needle eye. Preventive antimicrobial use has proven to have good results for patients using button eye techniques. The button needle eye puncture technique may be particularly suitable for patients with short fistulas [11]. According to the results of the Dialysis Outcomes and Practice Patterns Study (DOPPS) study, experienced nursing personnel (nursing experience with more than 3 years of experience in hemodialysis) can reduce the failure rate of AVF and AVG, emphasizing the importance of nursing personnel's experience in puncture nursing technology for vascular bypass results [17].

4. Conclusion

When selecting the most suitable puncture method, in addition to carefully assessing the patient's vascular access status, needs, and nursing personnel who assist in the puncture for the first time, no matter what technology is used, lack of experience can lead to vascular access complications. Therefore, it is necessary for dialysis nursing personnel to have professional knowledge, experience, and skills, closely evaluate and monitor the vascular function of the puncture site, and re-educate the puncture technology.

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