Types of vascular access in renal replacement therapy - nursing implications

(Rodzaje dostępów naczyniowych w leczeniu nerkozastępczym – implikacje pielęgnacyjne)

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Abstract – Introduction. Before the start of haemodialysis procedures, the patient must have access to large blood vessels. The purpose of this access is to allow adequate blood flow through the dialyser and to have a long service life and be safe for the patient. An arteriovenous fistula can be made from the patient's own vessels or using artificial material. The central catheter may be long-term or temporary. The choice of the type of vascular access depends on the patient's health condition and whether haemodialysis must be performed urgently. Therefore, proper care of the created access to blood vessels becomes so important.
The aim of the study. The aim of the study was to discuss the types of vascular access in renal replacement therapy, with particular attention paid to the care of the created vascular access.
Selection of material. The search was conducted in the Scopus database for the period 2002-2019, using the terms hemodialysis, non-tunnelled catheters, Seldinger method, tunnelled catheters, fistulas from own vessels, care of vascular accesses. From the literature found in the Google Scholar database, studies were selected which, in the opinion of the authors, would be most useful in the preparation of this study.
Conclusions. A dialysis patient should be fully aware that the possibility of haemodialysis and thus the achievement of an optimal quality of life in a difficult disease depends on their involvement. It is the duty of every patient to have a high sense of responsibility for the condition of their own vascular access and to cooperate constantly with nursing staff in this respect. If it is not possible to educate a patient, cooperation with the patient's immediate family is essential.

Key words **-** hemodialysis, non-tunnelled catheters, Seldinger's method, tunnelled catheters, fistulas from own vessels, care of vascular accesses.

Streszczenie – Wstęp. Przed rozpoczęciem zabiegów hemodializy musi być u pacjenta wytworzony dostęp do dużych naczyń krwionośnych. Ma on na celu umożliwić odpowiedni przepływ krwi przez dializator oraz posiadać długi okres używalności i być bezpiecznym dla pacjenta. Przetoka tętniczo-żylna może być wytworzona z naczyń własnych pacjenta lub z wykorzystaniem materiału sztucznego. Cewnik centralny może być długotermi nowy lub czasowy. Wybór rodzaju dostępu naczyniowego zależy od stanu zdrowia chorego i od tego czy hemodializy musza być wykonane w trybie pilnym. Dlatego tak ważna staje się właściwa pielęgnacja wytworzony dostęp do naczyń krwionośnych.
Cel pracy. Celem pracy było omówienie rodzajów dostępów naczyniowych w leczeniu nerkozastępczym, ze szczególnym zwróceniem uwagi na pielęgnację wytworzonego dostępu naczyniowego.
Dobór materiału. Poszukiwania przeprowadzono w bazie Scopus za okres 2002-2019, używając pojęć *hemodializa, cewniki nietunelizowane, metoda Seldingera, cewniki tunelizowane, przetoki z naczyń własnych, pielęgnacja dostępów naczyniowych*. Ze znalezionego w bazie Google Scholar piśmiennictwa wyselekcjonowano opracowania, które zdaniem autorów byłyby najbardziej użyteczne w przygotowaniu niniejszego opracowania.
Wnioski. Pacjent dializowany powinien mieć pełną świadomość, że od jego zaangażowania zależy możliwość wykonania zabiegu hemodializy, a tym samym osiągnięcie optymalnej jakości życia w trudnej chorobie. Obowiązkiem każdego pacjenta jest posiadanie wysokiego poczucia odpowiedzialności za stan własnego dostępu naczyniowego i stała współpraca pod tym względem z personelem pielęgniarskim. Jeżeli edukacja chorego nie jest możliwa, konieczna jest współpraca z najbliższą rodzina pacjenta.

Słowa kluczowe – hemodializa, cewniki nietunelizowane, metoda Seldingera, cewniki tunelizowane, przetoki z naczyń własnych, pielęgnacja dostępów naczyniowych.

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Authors' contributions to the article:

A. The idea and the planning of the study
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Accepted for publication: August 31, 2020.

I. INTRODUCTION

Before the start of haemodialysis procedures, the patient must have access to large blood vessels. The purpose of this access is to allow adequate blood flow through the dialyser and to have a long service life and be safe for the patient. The blood flow in a normal vein is too small to provide the required volume of blood to achieve effective dialysis. The creation and maintenance of adequate vascular access sometimes requires several visits to the vascular surgery department. An arteriovenous fistula or a central catheter is used for haemodialysis. An arteriovenous fistula may be made from the patient's own vessels or using artificial material. The central catheter may be long-term or temporary. The choice of the type of vascular access depends on the patient's health condition and whether haemodialysis must be performed urgently [1]. Often in patients requiring dialysis, there are numerous accompanying diseases, therefore the decision on the creation and type of vascular access is of great importance. In elderly patients, arterial vessels are significantly altered by atherosclerotic processes and tissue calcifications, and venous vessels by repeated blood sampling, which makes it difficult to create vascular access [2-6].

II. CATHETER NOT TUNNELLED

An untunnelled catheter is inserted if the patient's condition requires immediate initiation of haemodialysis treatment, which is why this catheter is called acute by some. It is a central puncture, i.e. insertion of the catheter into the jugular vein. An untunnelled catheter is a kind of flexible, unbreakable plastic tube. The procedure is performed under local anaesthesia and under conditions of full sterility. Insertion of the catheter takes about 30 minutes and enables immediate haemodialysis. However, it is a temporary catheter, usually used in short-term dialysis treatment in patients with acute renal failure or poisoning [7]. This two-channel catheter is usually inserted through the internal jugular or femoral vein, less frequently the subclavian one, due to a high risk of complications in the form of stenosis and thrombosis. The choice of place depends on the clinical situation. The catheter is inserted using the Seldinger method. After making a small skin incision, the vessel proper for the puncture is located with a needle. During the puncture, the syringes must be filled with saline to minimise the risk of air congestion. The catheter is inserted into the vessel after the previously inserted guide. After catheter insertion, its permeability should be checked and heparin should be filled in the appropriate amount according to the manufacturer's recommendations. It is necessary to sew the catheter to the skin to prevent it from slipping out or moving and to apply a sterile dressing. Radiological control of catheter position is also recommended [8-11].

III. TUNNELLED CATHETER

This catheter, also called a permanent or permanent vascular access, is increasingly common in patients who are unable to produce an arteriovenous fistula. A specially designed two-channel catheter is usually made of silicone. Unlike temporary catheters, it has a dacron muff, which grows together with the subcutaneous tissue, thus preventing the catheter from falling out and providing a defence against the penetration of pathogenic microorganisms. The catheter is inserted into a large venous vessel using surgical or percutaneous methods, similarly to a temporal catheter. During implantation, two small incisions are made to place the catheter in the subcutaneous canal on the chest wall and in one of the central veins. The first skin incision is the place of catheter insertion, i.e. the place where the catheter enters the blood vessel. The second place is the catheter's outlet, i.e. the point where the catheter goes out through the skin. The catheter's outlet requires special care. The tunnelled catheter is most often inserted into the internal jugular vein and its tip should be placed in 1/3 of the upper right atrium [10- 12].

IV. ARTERIO-VENOUS FISTULA MADE OF OWN VESSELS

The best vascular access for a patient is a fistula from his own vessels, because it is the safest and longest lasting. It shows less risk of complications than other vascular accesses and longer life span. It also allows for the highest blood flow and, as a result, the best hemodialysis results. Arterio-venous fistula is a surgical connection between a vein and an artery, thanks to which blood from the artery bypassing capillary vessels flows directly into a venous vessel. The vein receives blood under higher pressure, which occurs in the artery and is dilated. The wall of a chartered vein is stronger than a regular vein. The procedure is performed in the operating room under local or general anaesthesia. The time of operation depends on the difficulty of performing the procedure. The task of the surgeon producing the fistula is to obtain a section of about 12 centimetres of the vein on the anterior-lateral surface of the limb so that long haemodialysis procedures can be performed in a comfortable position for the patient [13]. When choosing a limb, a non-dominant limb is preferred, but the quality of the vessels is decisive.

The basic type of a fistula is a radial-radiated fistula, produced in the wrist area. The methods of joining are different. In the first fistulas, the side of the radial artery was connected with the side of the radial vein, however, due to venous hypertension that occurred within the hand, the connection was changed to "end to side". The end to side junction of the vein to the side of the artery is the preferred type of anastomosis. If it is not possible to create a fistula within the forearm, a radiant vein on the arm is used. In this case, the anastomosis is performed in the ulnar fossa. The choice of an arterial vessel depends on the quality of its wall and diameter. A fistula from own vessels can be used for haemodialysis only when it "matures". Usually this period lasts about 2 months and optimally 3-4 months. During this period, after healing and suture removal, the patient is obliged to perform appropriate exercises to prepare the fistula for puncture [14].

V.ARTERIAL-VENOUS FISTULA MADE OF PLASTIC

If the vessels are too small or very "weak" and it is not possible to create a fistula from the patient's own vessels, a vascular prosthesis is an alternative for the patient. This fistula, however, is characterized by a shorter time of use and a higher number of complications, especially inflammatory and thrombotic. Moreover, the pressure in the fistula is higher than in the own vessel fistula [48]. A vascular prosthesis may be used to create vascular access both within the arm and forearm in a straight section or as a loop. Due to the larger area to be punctured, a loop is preferable. The most commonly used denture is a polytetrafluoroethylene denture with a diameter of 6 millimetres. If it is not possible to insert a fistula within the upper limbs it is possible to create a vascular access on the lower limb or upper part of the chest. It is a subclavian-subclavian or brachial-neck fistula. After the creation of the fistula with a vascular prosthesis, antibiotic prophylaxis is recommended. An arterio-venous fistula with a vascular prosthesis can be punctured after 2 weeks. During this time, the plastic is rubbed with the patient's own tissues, which prevents the movement of the vascular prosthesis and reduces the risk of hematomas [10,11,15].

VI. CARE OF VASCULAR ACCESSES

Nursing care for a patient with freshly created vascular access is based on observation for complications and proper care and education of the patient in the care of vascular access. In each dialysis centre, a system of care for vascular access should be organised, consisting of monitoring its functioning. It is important for both the patient and the staff to function properly for as long as possible. Proper maintenance of a fistula and a vascular catheter is essential for maintaining optimal quality dialysis. Every surgical procedure is associated with the risk of dangerous complications. Improper care and ignoring the first disturbing signs in the area of vascular access may impair its functioning and adversely affect the patient's condition. A high level of knowledge on the part of nursing staff and patients is necessary to minimise the complications [16].

After catheter insertion, bleeding from the catheter insertion site may occur. The cause may be the supply of drugs decreasing coagulation or a haemorrhagic flaw resulting from the stage of chronic kidney failure and accidental damage to blood vessels during the procedure. It is necessary to change dressings in accordance with the principles of aseptic, use ice packings and observe the intensity of bleeding. In the case of heavy bleeding, a special antibacterial sponge soaked in polyhexamethylenebiguanidine with a T-shaped incision should be used. It is also advisable to control blood morphotic indicators.

Sometimes it happens that an inserted catheter does not function properly, which most often manifests itself as an

improper blood supply. The catheter may touch the wall of a blood vessel, which makes the flow difficult. Then the patient should be placed in a slightly different position or asked to cough. In some cases, the catheter needs to be replaced [17].

All operations on the vascular catheter must be carried out with particular attention to the principles of aseptics, as there is a high risk of infection, which may affect the internal surface, tunnel or external outlet of the catheter. The most common cause is contamination of the ends or site of its insertion with bacterial flora. Due to its sterility, the catheter should be used only for haemodialysis, except for life-threatening conditions.

The basic symptom of infection is rising body temperature during the treatment with accompanying chills, or fever after the treatment. It is advisable to take blood from a catheter for a culture. In case of symptoms of skin inflammation around the catheter's outlet, a smear should be taken. Before each haemodialysis, the nurse should assess the skin around the catheter's outlet for redness, swelling and exudate and measure body temperature.

When connecting the patient to the dialysis, a sterile napkin, gloves and dressing material and an alcohol-free disinfectant are required. The catheter tip protection caps must be changed after each procedure.

If an infection is diagnosed in a patient with a temporal catheter, it is removed. Permanent catheters are removed only if there is no response to antibiotic therapy and if there is evidence of catheter tunnel infection [18].

Patients dialyzed with a vascular catheter may develop catheter thrombosis. It most often occurs when the catheter is implanted into the femoral vein, because each bend of the limb pushes the anticoagulant into the bloodstream and in the catheter canal it is replaced with blood. Suspecting clots in the catheter, they should be removed by syringinges. Lack of effect means that the catheter needs to be replaced. Keeping the tunnelled catheter open is a serious problem. Total or partial thrombosis hinders free blood flow. [19,20]

It is essential that after haemodialysis, the catheter canals are filled with the agent inhibiting blood clotting in the amount corresponding to the channel length [21]. In prophylaxis of catheter infection, apart from nursing activities, the patient plays an important role. The patient should know the purpose of catheter insertion and the importance of its proper functioning. It is recommended that the patient should be able to recognize the symptoms of inflammation and report them immediately to the medical personnel. It is very important for the dressing on the catheter to be dry, therefore, he should avoid prolonged bathing in a bathtub or going to the pool. If there are no contraindications, a waterproof dressing is recommended. It is good to take a shower just before haemodialysis because a new dressing will be made. The patient needs to know that he cannot change the dressing on his own and, if it is flooded or unstuck, he should come to the dialysis centre for a new dressing urgently [22].

The execution of an arteriovenous fistula involves the risk of complications. Most often, after the procedure, swelling of the limb with the fistula, stopping blood flow in the fistula and infection of the postoperative wound can be observed. Excessive accumulation of lymphatic fluid in the intercellular space leads to oedema, which may be accompanied by a serous exudate hindering the healing of the postoperative wound. The cause may be the narrowing of veins in the course of blood flow from the fistula and the resulting inadequate blood flow. The treatment may take about six weeks and consists, among other things, in high limb position.

Thrombosis, i.e. stopping blood flow in the fistula, is mainly manifested by a lack of noise. Thrombosis, if it occurs early after the procedure, is a result of technical difficulties in the insertion of the fistula, caused by poor quality of vessels or compression by a hematoma. It may also occur as a result of a drop in blood pressure, significant dehydration, as well as measurement of pressure at the extremity with the fistula or intensive fistula training with too strong and prolonged clamping of the stoma. Thrombosis may also occur at a later stage due to peripheral or central constriction. Early detection of stenosis and activation of angioplasty or vascular stent implantation can avoid clots [23- 25].

The most common cause of infection of a surgical wound is an impaired immune system or lack of hygiene. The local infection manifests itself in redness, soreness and excessive warming. This is an early complication after vascular access is created, but inflammation of the fistula can occur at any stage. It is often a consequence of an improperly treated haematoma resulting from puncture of the vascular lumen. In addition to antibiotic treatment, anticoagulants are also administered. Extensive inflammation of the fistula which prevents its proper use requires temporary vascular access.

Complications within the fistula also include aneurysms, i.e. excessive widening of the vessel's lumen at a certain section of the fistula or along its entire length. This can be observed in the form of fistula "swelling" and deformations. The aneurysms are caused by frequent punctures in the same section of the fistula for dialysis purposes, or by abnormal blocking of bleeding from the fistula after removal of dialysis needles. Both aneurysms, fistula constrictions and inflammation are a problem which affects the

efficiency of the fistula and the quality of dialysis and requires surgical intervention [26].

Caring for an arterio-venous fistula is not only an activity which enables effective dialysis, but also contributes to prolonging the life of the fistula. Nursing staff should carefully observe vascular access and be able to recognise pathological changes within the fistula and know how to proceed in this respect. They should also be trained in the safe pricking and removal of needles from the fistula, and they should try to use the entire section of the fistula for pricking, observing the principles of aseptics. It is also advisable to gradually deepen professional knowledge in the area of care of vascular access and skilfully pass it on to patients. Caring for the fistula is the responsibility of both the medical staff and the patient himself. If possible, the patient's education should be started before renal replacement treatment is included. Patients with a newly created fistula must be allowed three to eight weeks before a hemodialysis can be carried out on it. The time depends on the type of fistula, the healing of the wound and the maturity of the fistula. A self-vascular fistula is the best type of vascular access, but it also requires the greatest commitment from the patient.

Arterio-venous fistula training is an exercise aimed at strengthening, thickening and making the walls of the vessels visible. The exercises facilitate repeated, safe puncture of the fistula and the risk of hematomas, constrictions and clots in the fistula. Training should begin after the stitches have been removed. In order for the patient to perform the exercises properly, the nurse should not only explain to the patient what the exercises consist of, but also show him how to perform them at home. A plastic fistula does not require preparatory training [27]. Every patient with a fistula should know where the anastomosis, i.e. the place where the artery and vein connect and be able to listen to the whole length of the fistula. It is important to control the fistula preferably on a daily basis, and in the absence of noise or other disturbing symptoms, he should immediately contact a dialysis centre. In order to prevent infections, personal hygiene, especially in the area of the fistula, should be taken care of. Before each hemodialysis procedure, the patient should first wash his hands with warm soapy water and then the area around the fistula. This allows to remove 60% of the bacteria on the skin and at the same time the vessels will be dilated, which will facilitate needle insertion. You cannot carry heavy objects over a kilogram in your hands with the fistula. Avoid pressing the fistula, for example, by measuring blood pressure, wearing tight clothes, watches or sleeping on your hands with the fistula. When doing "dirty work", the fistula must be secured but must not be bandaged firmly. Before a patient starts to bleed out after removing dialysis needles, they must know how to do it properly so as not to cause any complications. Both strength and time of compression are important. Dressings put on after dialysis should not be removed until after 12 hours. The patient must be aware that bleeding after needle removal can occur at home, so sterile gauze is necessary. If the bleeding is not stopped, it is necessary to consult a dialysis station doctor or visit the hospital emergency department. Each time you stay in another ward, you should inform the staff that you are on dialysis and have a fistula. Do not put on hands with a fistula or take blood for examination. Large weight gain between dialyses and the associated high dehydration is a metabolic shock to the body and may lead to clotting of the fistula. Regardless of vascular access, patients should take the medicines prescribed by the dialysis station doctor, especially anticoagulants, and should inform them about stays with other specialists and their recommendations. A dialysis patient should be fully aware that the possibility of haemodialysis, and thus the achievement of an optimal quality of life in a difficult disease, depends on their involvement. It is the duty of every patient to have a high sense of responsibility for their own vascular access and to cooperate constantly with nursing staff in this respect. If it is not possible to educate a patient, cooperation with the patient's immediate family is essential. [16-18,21-23,26]

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