# Vascular Access Management 1: An Overview

## *Vasküler Yol Yönetimi 1: Bir Görüş*

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*Özet*

*Renal replasman terapisi (RRT) için vasküler giriş yolunun açılması, multidisipliner nefroloji ekibinin karşı karşıya kaldığı en zor durumlardan biri olarak görülür. Tercih edilen vasküler giriş yolu arterio-venöz fistül (AVF) olup, arterio-venöz greft (AVF) ve santral venöz kateter (CVC) takip eden diğerleridir. Bir vasküler giriş proğramının başarılı olabilmesi için, giriş bölgesinin hazırlanmasına, oluşturulmasına ve matürasyonuna yeterli süre ayrılmasını sağlayacak bir düzenlemenin önceden yapılmış olması gerekir. Vasküler giriş kanülasyonunun başarıyla uygulanabilmesi için, nefroloji hemşiresinin, farklı kanülasyon tekniklerini kapsayan farklı tiplerdeki vasküler giriş yolu sağlama konusunda klinik bilgi ve uzmanlığa sahip olması gerekir.*

***Anahtar Kelimeler:*** *Kanülasyon tekniği, Eğitim, Hemodiyaliz, Matürasyon, Vasküler giriş yolu*

*Summary*

*Vascular access for renal replacement therapy (RRT) is seen as one of the most challenging areas confronting the nephrology multidisciplinary team. The vascular access of choice is the arterio-venous fistula (AVF) followed by the arterio-venous graft (AVG) and central venous catheter (CVC). A successful vascular access programme requires forward planning ensuring that enough time is available for the preservation of the access site, its creation and maturation. Successful cannulation of the vascular access requires on the part of the nephrology nurse, clinical expertise and knowledge on the management of different types of vascular access including different cannulation techniques.*

***Key Words:*** *Cannulation technique, Education, Haemodialysis, Maturation, Vascular access*

### AIM

The aim of this CE article is to provide a broad overview of vascular access so enabling the novice nephrology nurse to assist haemodialysis patients in the management of their own vascular access

### LEARNING OUTCOMES

After reading this CE article the reader should be able to:

- Identify different types of vascular access for use in RRT
- Examine International guidelines for recommendations on incidence, prevalence, insertion and management of different types of vascular access
- Discuss the management of patients with different types of vascular access using evidence based practice
- Outline patient education that will assist patients to self manage their own vascular access

### INTRODUCTION

The number of end stage renal disease (ESRD) patients requiring RRT worldwide has increased over the last ten years and it is predicted that this increase will continue further in the next 10 years (Frankel 2006). Haemodialysis is the predominate modality of RRT (The UK Renal Registry 2005; USRDS 2006). In order to provide adequate haemodialysis, there is a need for vascular access (VA) that functions well, has a low rate of complications and a long cumulative patency rate.

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**Time out activity**

Review a nephrology text book that is available to you in your clinical setting and from it identify key historical developments that have occurred in vascular access.

Managing patients' pre and post formation of VA is a fundamental role of the nephrology nurse. Therefore, this article, which is the first in a series of CE articles on vascular access, will provide an overview of the following: different types of VA, preparation of patients in advance of and management post formation. In addition, issues relating to cannulation and patient education will also be explored.

The last 50 years has seen major changes in the area of VA. Scribner and Quinton in 1960 developed the arterio-venous shunt (Figure 1), which required the insertion of Teflon tubes into an artery and a vein which were then joined together by a Teflon loop. Following this, Brescia et al. (1966) as cited by While (2006, p. 561) developed the first internal arterio-venous fistula, which is the gold standard for VA (White 2006). Presently, there are many different types of VA available to patients with ESRD.

**Time out activity**

Review a nephrology text book that is available to you in your clinical setting and from it identify key historical developments that have occurred in vascular access.

## INCIDENCE AND PREVALENCE

The VA of choice is the AVF with NKF-KDOQI Guidelines (2006) recommending a prevalence rate in renal centres of greater than 65%. This preference is linked to improved patient outcomes since patients with AVG and CVC experience increased episodes of infection, thrombosis, vascular access salvage procedures, higher rates of hospitalisations and death (Polkinghorne et al. 2004; Astor et al. 2005).

**Time out activity**

Review the Dialysis Outcomes and Practice Pattern Study (DOPPS) and examine this international longitudinal study in relation to incidence and prevalence of AVF, AVG and CVC across Europe.
http://www.dopps.org/dopps_default.aspx

Review and examine the impact international guidelines on vascular access practice have on your clinical practice:-

- European Best Practice Guidelines http://www.ndt-educational.org/guidelines.asp
- NKF-KDOQI Guidelines: http://www.kidney.org/professionals/KDOQI/guideline_upHD_PD_VA/index.htm

http://www.ndt-educational.org/guidelines.asp 
• NKF-KDOQI Guidelines: http://www.kidney.org/professionals/KDOQI/guideline_upHD_PD_VA/index.htm " hspace=12 src="cid: 000f01c9e873$81b8e130$0202a8c0@youre24c8d9bac" width=618 align=left v:shapes="_x0000_s1035">

DOPPS reports significant international differences in VA practices with 66% of European patients commencing dialysis using an AVF in contrast to 15% of USA patients. Prevalent rates also demonstrated a greater utilisation of AVF across Europe, accounting for 80% of all VA. Figures from the USA suggest that the predominate access type in prevalent patients was an AVG (58%) (Pisoni et al. 2002).

International guidelines discourage the utilisation of CVC because of the numerous complications associated with their use (CARI 2000; NKF K/DOQI 2006; Tordoir et al. 2007).

***Figure 1:*** *Arterio-venous shunt (Van Waeleghem and De Weerdt 1988)*

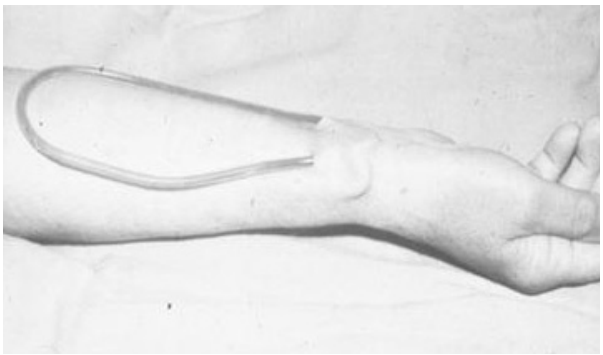

***Table 1:*** *High use of CVC.*

| *High use of CVC* |
|---|
| • *Late referral to nephrologist* |
| • *Delay in access formation* |
| • *Lack of sufficient time for AVF to mature* |
| • *Vascular disease* |
| • *Diabetic disease* |
| • *Increasing older population of patients with an inadequate vasculature for VA* |
| • *Preferences of nephrology medical and nursing staff* |

*(Young et al. 2002; Letourneau et al. 2003; Mendelssohn et al. 2006)*

Indeed, NKF-K/DOQI (2006) guidelines recommend they be inserted into less than 10% of prevalent patients. However, DOPPS II study indicates that 46% of European and 66% of USA patients commence haemodialysis via a CVC (Mendelssohn et al. 2006). Reasons for this dependence on CVC are listed in Table 1.

## AVF AND AVG

The preferable site for AVF and AVG is the non dominant arm, commencing distally so leaving the proximal vessels for future access. Where there are no vessels available it may be necessary to site further VA in the legs. Lower limbs are less desirable since they are more prone to infection, thrombosis and ischemia (Brunier 1996; Hartigan and White 2001; NKF K/DOQI 2006; Tordoir et al. 2007).

**Time out activity**

Outline the advantages and disadvantages of using an AVF/AVG.

An AVF involves the anastomosis of an artery with a vein in which allows arterial blood to flow through the vein causing venous enlargement, engorgement and thickening of the venous wall. In order of preference an AVF can be created using the following vessels (Fig. 2):

1. Radio-cephalic at the wrist
2. Brachio-cephalic at the elbow
3. Brachio-basilic (transposed basilica vein)

(NKF K/DOQI 2006; Tordoir et al. 2007)

Table 2 outlines the advantages and disadvantages of AVF.

When all efforts to establish a functioning AVF fail the next preferred access is an AVG made of either biological or synthetic materials (NKF K/DOQI 2006; Tordoir et al. 2007). An AVG can be a straight, looped or a curved configuration with the ends of the graft attached to sides of an artery and vein. They can be placed in the forearm (Figure 3), upper arm and thighs. Table 3 outlines the advantages and disadvantages of AVG.

***Figure 2:*** *Anatomical sites of fore arm, elbow and upper arm AVF. (Van Waeleghem and De Weerdt 1988)*

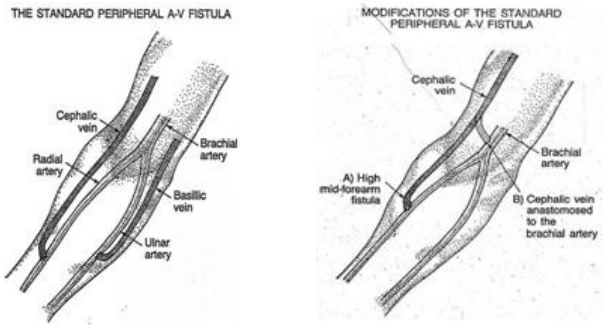


***Table 2:*** *Advantages and disadvantages of AVF.*

| *Advantages and disadvantages of AVF* | |
|---|---|
| ***Advantages*** | ***Disadvantages*** |
| • *Low clotting rate* | • *Long maturation time* |
| • *Low infection rate* | • *Failure to mature (20%)* |
| • *Longevity (70% patency after 3 years)* | • *Difficult to cannulate* |
| • *Healing of cannulation sites* | • *Visibility of fistulae* |
| | • *Formation of aneurysm* |

*(Hartigan and White 2001; Roy-Chaudhury et al. 2005)*

## PREPARING THE PATIENT FOR VASCULAR ACCESS

VA is one of the most challenging areas of care confronting the nephrology team and is still regarded as the "Achilles heel" of the haemodialysis patient. There is a need for a multi-disciplinary team approach whereby the patient needs to be well prepared physical and psychological for access surgery. Additionally, forward planning ensures sufficient time is available for the preservation of the access site, its creation and maturation. An AVF should be created at least six months before the start of dialysis to avoid commencing dialysis with a CVC (NKF K/DOQI 2006). An AVG can be inserted two to three weeks before the first dialysis session (Merrill et al. 2005).

**Time out activity**

What measures can you take to ensure the preservation of patients veins?

### Vein preservation

Veins must be preserved in patients with declining renal function and those undergoing any form of renal replacement therapy. The following actions are needed to ensure preservation of veins in both arms:

- Avoid intravenous infusion and venepuncture
- Use dorsal veins for venepuncture and intravenous infusions
- The subclavian vein should not be used for CVC

• During hospitalisation, indicate that no venepunctures should be done in those veins most likely to be used in future vascular access

• Educate the patient and their family

• Educate all hospital staff on the necessary measures to preserve veins of future dialysis patients

(Van Waeleghem et al. 2004)

### Pre operative investigations

An important part of planning the creation of VA involves the surgical team carrying out the following actions:

*1. Medical history*

Age, previous CVC, cardiac and vascular diseases, stroke and neurological diseases, joint diseases, local infection and dermatological diseases are important to consider before planning the intervention.

*2. Physical examination*

Palpation and auscultation of arteries as well as palpation of veins should be performed in all patients. In the event where no suitable vessels are visible, a Doppler echography should be performed.

*3. Technical examinations/investigations*

Various examinations are possible such as the Duplex ultrasound, Digital angiography (MRA), vein mapping, X rays of soft tissues and magnetic resonance angiography. The two most frequent examinations used are Duplex ultrasound and vein mapping. When an AVG is being considered, it is important to examine possible veins and arteries as these patients would have been assessed as having veins and arteries that were not suitable for the creation of an AVF.

**Time out activity**

Within the first 24 hours post AVF formation what should your assessment of the patient include?

***Figure 3:*** *Looped AVG.*
*(Van Waeleghem and De Weerdt 1988)*

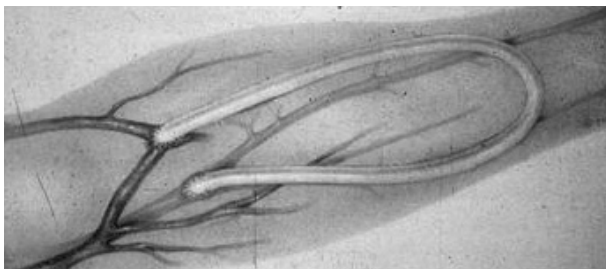

***Table 3:*** *Advantages and disadvantages of AVG.*

| *Advantages and disadvantages of AVG* | |
|---|---|
| ***Advantages*** | ***Disadvantages*** |
| *• Short maturation time* | *• Risk of Infection* |
| *• Large cannulation area* | *• Thrombosis* |
| *• Easier cannulation* | *• Risk of allergic reaction to synthetic material* |
| *• Size and blood flow not dependent on vein maturation* | *• Stenosis* |
| | *• Short lifespan (three to five years)* |
| | *• Puncture site does not heal, it seals* |

*(Hartigan and White 2001; Roy-Chaudhury et al. 2005)*

## POST OPERATIVE MANAGEMENT OF AVF AND AVG

There are several complications that have to be observed for during the post operative phase. The most common are circulatory problems and infection. The surgical area should be kept warm and in a comfortable position. The blood pressure should be checked regularly and the systolic pressure should be above 100mmHg. If it is below 100mmHg the peripheral circulation may be affected with increased risk of vascular access thrombosis (Brunier 1996; Thomas 2002).

The blood flow through the VA should be assessed regularly, first every half hour then with declining intervals until discharge. The assessment should include:

• Listening with a stethoscope for a bruit (buzzing or whooshing sound heard)

• A palpable thrill at the anastomosis (buzzing sensation can be felt)

• Observing for signs and symptoms of local and systemic infection (Brunier 1996; Thomas 2002)

Patients education should start when selection of access type is discussed (Table 4).

**Time out activity**

Read the following article which outlines EDTNA/ERCA vascular access recommendations and explore its relevance to clinical practice.

Van Waeleghem, J.P., Elseviers, M., De Vos, JY., Glorieux, W. (2004). EDTNA/ERCA vascular recommendations for nephrology nurses. *EDTNA /ERCA Journal* **20** (2), 97-105.

## ACCESSING AVF AND AVG

For an AVF located in the forearm maturation time is between four to six weeks while maturation time for an AVF located in the elbow and upper arm may be three to four weeks (Merrill et al. 2005). If maturation takes longer, a stenosis should be suspected either at the arterial inflow or at the venous outflow. The maturation time for an AVG is between two and three weeks (Merrill et al. 2005).

**Time out activity**

What type of puncturing techniques do you use in your unit when cannulating?

### Cannulation techniques and procedures

Cannulation is one of the most important manipulations of dialysis therapy and nephrology nurses need to keep up to date with current developments in this area. During first cannulation, an experienced nurse should develop an optimal nurse-patient relationship in order to create a relaxing atmosphere to perform the cannulation. For the continuity of VA care, it is important to document all details concerning the access flow and puncture technique. First cannulations are usually done with a 16- or 17- gauge needle in order to minimise access trauma (Elseviers et al. 2003).

Prior to cannulation, the patient should wash the VA site with soap and water followed by disinfection as per unit protocol (Van Waeleghem et al. 2004). Elseviers et al. (2003) reported findings, which indicated that this washing procedure reduced vascular access infection significantly (Figure 4).

The use of a tourniquet is advised in order to enlarge the diameter of the vessels to be punctured. In AVG with a loop configuration, manual compression at the outflow of the graft may be used during cannulation. Cannulation in all AVF should be performed using an angle of about 25%, while an angle of 45% should be used on AVG. This reduces bleeding time after withdrawal of the needles (Verhallen et al. 2007). The cannulation itself consists mainly of two manipulations:

- Puncture of the access vessel
- Further introduction of the needle into the vessel

There are mainly three different puncture techniques (Figure 5):

1. Rope ladder
2. Area puncture
3. Button hole

The rope ladder technique is currently the most popular technique whereby the punctures sites are spread equally along the length of the VA. Area puncture is a technique where needles are inserted within a limited area of the fistula. This technique is not advised due to the following complications:

- Aneurysm formation
- Thinning of the skin at puncture sites
- Bleeding along the needles
- Longer bleeding time after needle withdrawal

***Table 4:*** *Patient education on management of VA.*

| *Patient education on management of VA* |
|---|
| • *Post operative arm exercise to accelerate maturation (use either rubber ball or tennis ball and squeeze four to five minutes several times a day once suture line is healed)* |
| • *Learn to palpate for thrill and bruit* |
| • *Recognise and report signs and symptoms of infection* |
| • *Report changes in VA* |
| • *Avoid sleeping on side of access* |
| • *Avoid clothes that might hamper VA blood flow* |
| • *Should learn the flow direction in AVG and the correct needle placement* |
| • *Learn how to stop bleeding that may occur* |
| • *Ensure that no healthcare worker inserts an IV cannula or takes blood or blood pressure measurements in AVF arm* |
| • *Ensure that health care staff clean site prior to cannulation* |
| • *As AVG consists of synthetic material. Patient is taught about the need for prophylactic antibiotics prior to dental surgery and any invasive procedures* |
| *(Van Waeleghem et al. 2004)* |

The buttonhole technique consists of puncturing the same place, in the same direction and at the same angle and depth. The first eight to twelve punctures are performed using a sharp classic needle. From then onwards, a tract is formed and a blunt needle can be used to puncture the access (Verhallen et al. 2007).

## CENTRAL VENOUS CATHETERS

CVC can be either nontunnelled or tunnelled. A nontunnelled CVC is often referred to in the literature as temporary, short term, acute or noncuffed. In contrast, tunnelled CVC are known as either chronic, long term, permanent or cuffed catheters. Tunnelled catheters are recommended when haemodialysis is required for more than two to three weeks (Frankel 2006). However, it is evident from the literature that tunnelled catheters have been used for periods of short duration and although not recommended nontunnelled CVC have been used for long-term haemodialysis (Ponikvar 2005; NKF K/DOQI 2006).

The preferred site for insertion of the CVC, either single or dual lumen, is the right internal jugular vein as it offers a direct route to the right atrium, which is the ideal site for locating the tip of the catheter (Work 2001; NKF K/DOQI 2006). The second preferred site is usually determined by the individual circumstances of the patient; however; European Best Practice Guidelines (EBPG) suggest the left inter-

***Figure 4:*** *Impact of washing procedure on infection rates (Elseviers et al. 2003)*

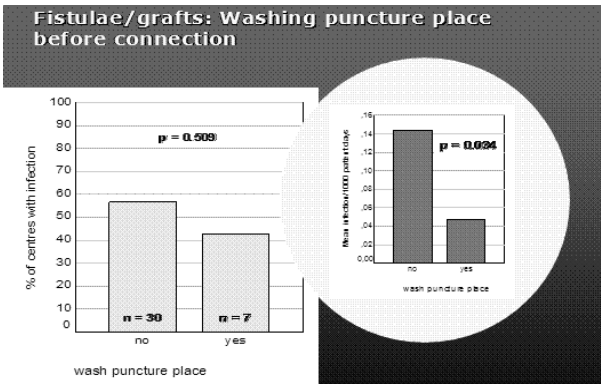


***Figure 5:*** *Three different puncture techniques. (Van Waeleghem and De Weerdt 1988)*

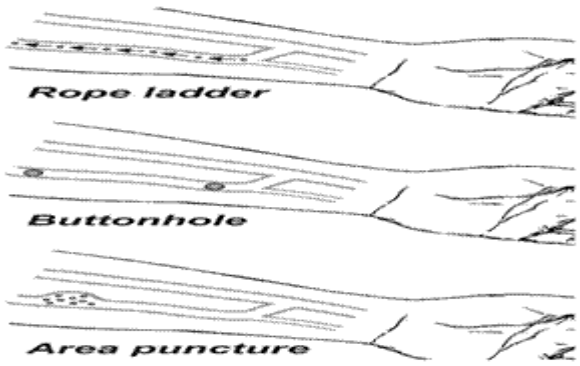


***Table 5:*** *Interventions preventing CVC infection.*

| *Interventions preventing CVC infection* | |
|---|---|
| • *Only trained personnel allowed to manipulate and change haemodialysis catheter dressings* | • *Chlorhexidine 2% with 70% alcohol (KD) 1 to clean exit site* |
| • *Correct hand hygiene* | • *Chlorhexidine aqueous or povidone solution for patients with skin sensitivity* |
| • *Clean gloves for all connections, disconnections and dressing procedures* | • *Clean caps and ports with chlorhexidine / betadine [1]* |
| • *Aseptic no touch technique for all connections, disconnections and dressing procedures* | • *Apply chlorhexidine / mupirocin or povidone iodine ointment to exit site[2]* |
| • *Change of dressing at the end of each treatment* | • *Catheter should be fixed to avoid unnecessary traction* |
| • *Dry gauze or transparent dressing can be used* | • *Surgical masks for staff and patients at time of CVC dressing change* |
| | • *Debate continuous on use of locking solutions with both antithrombotic and antimicrobial properties and the use of antimicrobial impregnated catheters* |

*(CARI 2000; ERA-EDTA 2002; NKF K/DOQI 2006; Tordoir et al. 2007*

nal jugular vein (Tordoir et al. 2007).

### Management of CVC

Insertion of CVC should be carried out in a clean environment under strict aseptic technique by trained senior personnel using real-time ultrasound guidance to assist cannulation of the vein (NKF K/DOQI 2006; Tordoir et al. 2007). A plain x-ray (chest or abdomen) is performed post insertion and prior to CVC use to determine its location and detect any complications, for example pneumothorax. Prevention of CVC infection is an important goal for the nephrology nurse. International guidelines differ in their advice on interventions preventing CVC related infection (Table 5). It is therefore important that evidence-based protocols be developed at local level.

## CONCLUSION

It is important that the multidisciplinary nephrology team recognise international guidelines, which indicate that an AVF is the preferred vascular choice. Early referral for vascular access formation is a priority in the management of patients with ESRD. The creation of an AVF should first use the distal vessels in the arms leaving the more proximally vessels for future access. An AVG should only be considered when the formation of an AVF is not possible, while a CVC should only be used as a last resort. A successful vascular access programme involves forward planning which includes the preservation of veins, evaluating the suitability of blood vessels prior to vascular formation, the creation of the VA and the allotment of allowing sufficient time for it to mature. Nephrology nurses as part of the multidisciplinary team, have an important role in the management of VA. They are required to have the necessary knowledge and clinical expertise in cannulation and long term management of all types of vascular access. This CE article provides an overview of vascular access and aims to develop the nephrology nurses knowledge and understanding of vascular access so contributing to their professional development in this area.

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[1] Manufacturers recommendations need to be followed in relation to the types of cleaning agents that can be used on the CVC material.

[2] As per local policy.