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GUIDELINES GOR CLINICAL PRACTICE

Vascular access today

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Abstract

The number of patients with chronic kidney disease requiring renal replacement therapy has increased worldwide. The most common replacement therapy is hemodialysis (HD). Vascular access (VA) has a key role for successful treatment. Despite the advances that have taken place in the field of the HD procedure, few things have changed with regards to VA in recent years. Arteriovenous fistula (AVF), polytetrafluoroethylene graft and the cuffed double lumen silicone catheter are the most common used for VA. In the long term, a number of complications may present and more than one VA is needed during the HD life. The most common complications for all of VA types are thrombosis, bleeding and infection, the most common cause of morbidity in these patients. It has been estimated that VA dysfunction is responsible for 20% of all hospitalizations. The annual cost of placing and looking after dialysis VA in the United States exceeds 1 billion dollars per year. A good functional access is also vital in order to deliver adequate HD therapy. It seems that the native AVF that Brescia and Cimino described in 1966 still remains the first choice for VA. The native forearm AVFs have the longest survival and require the fewest interventions. For this reason, the forearm AVF is the first choice, followed by the upper-arm AVF, the arteriovenous graft and the cuffed central venous catheter is the final choice. In conclusion, VA remains the most important issue for patients on HD and despite the technical improvements, a number of problems and complications have to be resolved.

Key words: Hemodialysis; Vascular access; Arteriovenous fistula; Arteriovenous graft; Central venous catheter; Cuffed central venous catheter

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INTRODUCTION

The number of patients with end-stage chronic kidney disease (CKD) requiring renal replacement therapy has increased progressively worldwide[1]. Permanent vascular access (VA) is the life-line for the majority of these patients when hemodialysis (HD) is the treatment of choice. Thus, the successful creation of permanent VA and the appropriate management to decrease the complications is mandatory. A good functional access is also vital in order to deliver adequate HD therapy in end-stage renal disease (ESRD) patients. Despite the advances that have taken place in the field of nephrology and particularly in dialysis, few things have changed in recent years with regards to VA, mainly the introduction of the polytetrafluoroethylene graft and the cuffed double lumen silicone catheter. However, the cost of VA related care was found to be more than five-fold higher for patients with arteriovenous graft (AVG) compared to patients with a functioning arteriovenous fistula (AVF)[2]. It seems that the native AVF that Brescia and Cimino described in 1966 still remains the first choice for VA[3]. Thereafter, VA still remains the "Achilles' heel" of the procedure[4] and HD VA dysfunction is one of the most important causes of morbidity in this population[5]. It has been estimated that VA dysfunction is responsible for 20% of all hospitalizations; the annual cost of placing and looking after dialysis VA in the United States exceeds 1 billion dollars per year[6,7]. Nowadays, three types of permanent VA are being used: AVF, AVG and cuffed central venous catheters (CVC). They all have to be able to provide enough blood flow to deliver adequate HD, to have a long use life and a low rate of complications. The native forearm AVF has the longest survival and requires the fewest interventions. For this reason, the forearm AVF is the first choice, followed by the upper-arm AVF, the AVG and the cuffed CVC as the final step[8-10].

The history of HD VA is closely associated with the history of dialysis. Haas[11] performed the first HD treatment in humans using glass cannulae to acquire blood from the radial artery and reverting it to the cubital vein in 1924. In 1943, venepuncture needles were used by Kolff[12,13] for blood acquisition from the femoral artery and its reinfusion to the patient by vein puncture. Quinton *et al*[14] developed the arteriovenous Teflon shunt in the 60s. In 1966, Brescia, Cimino, Appel and Hurwich published their paper about AVF. In 1968 Röhl *et al*[15] published thirty radial-artery-side-to-vein-end anastomoses. Today, the artery-side-to-vein-end anastomosis has become a standard procedure[16]. In 1976, Baker *et al*[17] presented the first results with expanded PTFE grafts in 72 HD patients.

Prevalence rate of different types of VA

There are many differences worldwide in the most common type of VA being used. In Australia among adults patients on HD, separated into incident (< 150 d since first dialysis) and prevalent cohorts (⩾ 150 d), AVF was present in 61% *vs* 77%, AVG was present in 11% *vs* 19%, and CVC was present in 28% *vs* 4% in the incident and prevalent cohorts, respectively[18]. A direct broad-based comparison of VA use and survival in Europe (EUR) and the United States was reported in a representative study [Dialysis outcomes and practice patterns study, (DOPPS)] which used the same data collection protocol for more than 6400 HD patients to compare VA use at 145 United States dialysis units and 101 units in five European countries (France, Germany, Italy, Spain and the United Kingdom). AVF was used by 80% of European and 24% of United States prevalent patients and was significantly associated with younger age, male gender, lower body mass index, non-diabetic status, lack of peripheral vascular disease and no angina. After adjusting for these factors, AVF *vs* graft use was still much higher in Europe than United States (AVF use 83% *vs* 21%). For patients who were new to HD, access use was: 66% AVF in Europe *vs* 15% in United States, 31% catheters in Europe *vs* 60% in United States, and 2% grafts in Europe *vs* 24% in United States. In addition, 25% of European and 46% of United States incident patients did not have a permanent access placed prior to starting HD. In Europe, 84% of new HD patients had seen a nephrologist for more than 30 d prior to ESRD compared with 74% in the United States; pre-ESRD care was associated with increased odds of AVF *vs* graft use. AVF and grafts each displayed better survival if used when initiating HD compared with being used after patients began dialysis with a catheter[19].

According to the study by Ethier *et al*[20] which was based on data from DOPPS, from more than 300 HD units from 12 countries and more than 35 000 patients, international trends in VA use and trends in patient characteristics and practices associated with VA use from 1996 to 2007 were examined. Since 2005, a native AVF was used by 67%-91% of prevalent patients in Japan, Italy, Germany, France, Spain, the UK, Australia and New Zealand, and 50%-59% in Belgium, Sweden and Canada. From 1996 to 2007, AVF use rose from 24% to 47% in the United States but declined in Italy, Germany and Spain. Moreover, graft use fell by 50% in the United States from 58% use in 1996 to 28% by 2007. Across three phases of data collection, patients consistently were less likely to use an AVF *vs* other VA types if female, of older age, having greater body mass index, diabetes, peripheral vascular disease or recurrent cellulitis/gangrene. In addition, countries with a greater prevalence of diabetes in HD patients had a significantly lower percentage of patients using an AVF. Despite poorer outcomes for central vein catheters, catheter use rose 1.5 to 3-fold among prevalent patients in many countries from 1996 to 2007, even among 18-70 years old non-diabetic patients. Furthermore, 58%-73% of patients new to ESRD used a catheter for the initiation of HD in five countries, despite 60%-79% of patients having been seen by a nephrologist > 4 mo prior to ESRD. Compared to patients using an AVF, patients with a catheter displayed significantly lower mean Kt/V levels. A secondary analysis of the Membrane Permeability Outcome (MPO) study by Martin-Malo *et al*[21] grouped participating countries according to geographical location; thus study centers in France, Greece, Italy, Portugal and Spain were allocated to southern Europe (n = 499), and those in all other countries (Belgium, Germany, Poland and Sweden) to northern Europe (n = 148). In patients from the northern European countries, a higher prevalence of diabetes mellitus and cardiovascular disease was observed than in those from southern Europe (diabetes 35.1% *vs* 21.0%; cardiovascular disease 40.5% *vs* 22.8%). In northern Europe, 23% of patients started HD with a catheter for VA, while in southern European centers, only 13% did so. According to a nationwide statistical survey of 4081 dialysis facilities in Japan at the end of 2008, the number of patients undergoing dialysis was determined to be 283 421. Regarding the type of VA in patients treated by facility dialysis, in 89.7% of patients an AVF was used and in 7.1% an AVG was used[22]. According to a single center study in China by Yu *et al*[23] of 376 maintenance HD patients, 97.87% had native AVFs, 1.33% had AVG and only 0.80% had cuff catheter. Swarnalatha *et al*[24], in their study from a tertiary care center in India with 237 new HD patients in a three year period, report that AVF was secured in 29.95% of patients at presentation and internal jugular catheter was the most common form of VA at initiation of HD, taking into account that 65.40% of patients had emergency HD.

Temporary VA

This type of access is used when urgent HD has to be performed and the need for an appropriate VA becomes immediate. Two types of such accesses are currently available: non-tunneled dialysis catheters and cuffed, tunneled dialysis catheters. Double-lumen, non-cuffed, non-tunneled HD catheters are the most frequently used for acute HD when long-term access is not available. They are made of polymers which are rigid at room temperature so as to facilitate insertion but soften at body temperature to minimize vessel injury and blood vessel laceration.

Jugular, subclavian or femoral central veins can be used as insertion routes for these catheters[25]. The femoral vein can be used as an access central vein when all others have been excluded. The 2006 National Kidney Foundation Dialysis Outcomes Quality Initiative (K/DOQI) guidelines recommend, after internal jugular or subclavian vein insertion, radiographic identification of any potential complications and confirming tip placement prior to either anticoagulation or catheter use[26]. Nowadays, the subclavian catheters should be generally avoided because of the high incidence of vein stenosis and thrombosis.

The K/DOQI guidelines suggest non-cuffed, non-tunneled catheters to be used for less than one week and that cuffed, tunneled catheters be placed for those who require dialysis for longer than one week[26]. Non-tunneled double lumen catheters complications are divided in early ones, usually during insertion, and the late ones, such as infection and thrombosis of the vessels. Infectious complications are the principal reason for catheter removal.

There is conflicting evidence concerning the risk of infection based on the site of insertion. In a large prospective randomized study (750 patients), the risk of infection was not reduced with jugular *vs* femoral venous catheterization[27]. But other prospective nonrandomized studies suggest that the infection risk appears to sequentially increase for HD catheters inserted into the subclavian, internal jugular and femoral veins, respectively[28,29]. Coagulase-negative staphylococci, *staphylococcus aureus*, aerobic gram-negative bacilli and *Candida albicans* most commonly cause catheter-related bloodstream infection.

Permanent VA

The decision for the appropriate VA takes patient dependent factors such as life expectancy, co morbidities, circulatory system status and the characteristics of access itself into consideration. Also, the duration of VA's functionality and the risk for infection and thrombosis are important factors to consider. Each type of surgical anastomosis has its advantages and disadvantages[30]. A formalized predialysis pathway, including patient education and eGFR thresholds for access placement, is associated with improved permanent VA placement[31]. According to Rodriguez *et al*[32], venepunctures and catheterizations in the upper extremities should be avoided to reduce the incidence of venous occlusions and stenosis (strength of recommendation B). When necessary, a complementary examination by Doppler ultrasound (strength of recommendation B) or phlebography may be performed. Kim *et al*[33] found that low values of early VA blood flow (VABF) parameters were associated with the development of VA events, especially VA stenosis. This suggests that some of the VABF parameters in the early period of VA creation may predict long-term VA patency in incident HD patients. For long-term access, the autogenous access is always the preferred access type given its favorable longevity. Surgeons should focus on distal sites on the extremity, reserving proximal sites for potential future access. In the absence of a suitable vein, prosthetic access may be considered[34]. Chou *et al*[35,36] state that serum CRP levels not only predict cardiovascular disease and mortality in HD patients, but also predict the development of VA thrombosis (VAT), and that high pulse pressure (PP) was associated with the development of VAT in chronic HD patients. Far-infrared (FIR) therapy, a non-invasive and convenient therapeutic modality, can improve access blood flow (Qa) and survival of the AVF in HD patients through both its thermal and non-thermal effects[37]. Shuman *et al*[38] suggest that an organized clinical assessment, using a formal tracking tool, is equal to ultrasound flow measurements as a surveillance method to prevent HD access thrombosis. Aiming for an early access dysfunction diagnosis and elective repair of the failing access, the DOQI guidelines recommend that all HD patients undergo a program of regular monitoring and surveillance. The K/DOQI 2000 update identifies specific types of evaluation for dialysis accesses. Firstly, nephrologists should examine patients by inspecting, ausculting and palpating the access at least every 4-6 wk when patients are not being dialyzed. In addition, access surveillance should be regularly performed by various techniques, i.e., urea recirculation test, dialysis venous pressure measurement and access blood flow assessment. Recently, many methods have been proposed and implemented. Ultrasound dilution is the most commonly used. This technique relies on the change in ultrasound velocity when blood is diluted with a normal saline bolus at a known dialyzer blood flow rate after the lines have been reversed. Following the use of blood ultrasound dilution, multiple technologies have been implemented for access flow measurement with line reversal, i.e., hematocrit (Hct) dilution, thermodilution, conductivity variation assessment. There are three other methods that do not require line reversal: transcutaneous access flow (TQA) assessment, glucose pump test (GPT) and the variable flow Doppler. Finally, duplex scanning can provide both the anatomy and blood flow of the access. With a Qa < 600 mL/min or < 1000 mL/min but reduced by 25% in 4 mo, K/DOQI suggest performing angiography and eventual elective repair[39]. It seems that a genotype of Factor V (rs6019) is associated with increased risk of graft failure. Anticoagulation may reduce graft failure in patients with this genotype[40]. Osborn *et al*[41] in their meta-analysis report the beneficial effect of anti-platelet treatment as an adjuvant used to increase the patency of A-V fistulae and grafts in the short term. Paulson *et al*[42] state that current evidence does not support the concept that all accesses should undergo routine surveillance with intervention. New techniques, such as preemptive skin and vein biopsy and cold-preserving autologous tissue, allow the immediate availability of an autologous AVF and are an important step forward in our strategy to provide allogeneic tissue-engineered grafts available "off-the-shelf"[43]. Agents such as fish oil and angiotensin-converting enzyme inhibitors have shown some effect in increasing the patency in AV grafts and fistulas[44]. Jackson *et al*[45] suggest that therapy with an ARB plus antiplatelet agent is associated with prolonged autogenous access primary patency and therapy with an ARB with or without antiplatelet agents is linked with prolonged prosthetic access primary patency. Although arterial image quality and vessel-to-background ratios were lower, NCE-MRA is considered as a feasible alternative to CE-MRA in patients with ESRD who need imaging of the upper extremity and central vasculature prior to dialysis access creation[46]. Doelman *et al*[47] suggest that Color Doppler ultrasonography (CDUS) be used as initial imaging modality of dysfunctional shunts but complete access should be depicted at digital subtraction angiography (DSA) and angioplasty to detect all significant stenoses eligible for intervention. Multidetector row computed tomographic (MDCT) angiography provides excellent correlation in vascular stenosis compared with conventional DSA in HD access. Complete assessment of entire vascular segments could be performed with MDCT angiography in planning before endovascular intervention or surgical correction[48].

Arteriovenous fistula: It is the preferred type of VA because it has the lowest complication rates for thrombosis and infection[49,50]. The most common surgical technique today is the side-to-end anastomosis. AVF placement should be initiated when the patient reaches CKD stage 4 or within 1 year of the anticipated start of dialysis. A physical examination should document blood pressure differences between the upper extremities[51] and an Allen test should be performed as the lack of a well-developed palmar arch predispose for vascular steal symptoms in case the dominant artery is used for the VA creation[52]. Smith *et al*[53] suggest that patient factors, such as increasing age, presence of diabetes, smoking, peripheral vascular disease, predialysis hypotension and vessel characteristics, directly influence AVF patency. Vessels of small caliber (< 2 mm) or demonstrating reduced distensibility are unlikely to create a functional AVF. Current evidence does not support altered patency due to sex or raised body mass index (< 35 kg/m^2). Factors such as early referral for AVF, preoperative ultrasound vessel mapping, use of vascular staples and intra-operative flow measurements affect AVF patency, but the use of medical adjuvant therapies does not. Programs of surveillance and various needling techniques to maintain patency are not supported by current evidence. Novel techniques of infrared radiotherapy and topical glyceryl trinitrate are possible future strategies to increase AVF patency rates. The limitations of available evidence include a lack of large, randomized controlled trials and meta-analysis data to support current practice. Routine preoperative upper extremity mapping with ultrasound not only increases AVF construction rate, but also their maturation likelihood[54]. A new surgical approach for VA for HD using a latero-lateral AVF in the thigh between the femoral artery and superficial femoral vein transposed to the subcutaneous layer in patients with no other access options is described by Cerri *et al*[55]. The new surgical approach for access for HD represents a feasible procedure, with acceptable patency rates in exceptional cases where no other access option is available. The study by Tessitore *et al*[56] showed that fistula stenosis can be detected and located during dialysis with a moderate-to-excellent accuracy using physical examination and Qa measurement as screening procedures, or ultrasound dilution Qa measurement which is a reproducible and highly accurate tool for detecting stenosis and predicting thrombosis in forearm AVFs. Neither Qa/MAP nor dQa improve the diagnostic performance of Qa alone, although its combination with dQa increases the test's sensitivity for stenosis[57], and all these diagnostic tests with respect to the value of physical examination itself[58]. Hemoglobin dilution technique can be used to measure VA flow but requires validation against clinical outcomes before being recommended as an alternative to UDT[59]. Balloon-assisted maturation (BAM) techniques can be an effective tool to help a dialysis patient achieve an adequately mature AVF. Additional vascular interventional techniques may be utilized to further improve clinical results; this technique is the so called "augmented balloon-assisted maturation" or aBAM[60].

Arteriovenous fistulas complications: Complications of AVFs can be divided into early and late causes. Early causes include inflow problems due to small or atherosclerotic arteries or juxta-anastomotic stenosis, so a preoperative evaluation for suitable access sites has to be performed[61]. Late causes for failure of AVFs include venous stenosis, thrombosis and acquired arterial lesions, such as aneurysms or stenoses. In the study by Fokou *et al*[62], an overall frequency of complications of 16% is shown. These results show the potential for a low complication rate of AVF in a selected population. A side effect of AVF is the ischemia of the extremity (steal syndrome). Callaghan *et al*[63] support that "revision using distal inflow" was successful in treating dialysis access-associated steal syndrome (DASS) but a high rate of AVF failure was seen. The distal revascularization interval-ligation procedure has demonstrated efficacy in the management of DASS[64]. Covered stents or stent grafts are exciting new products with multiple applications for patients with vascular disease, including HD access-related complications. It is clear that stent grafts provide a rapid, effective means for endovascular repair of ruptured access vessels. Their current applications for treating access-related complications, including aneurysms/pseudoaneurysms, venous outflow stenoses, cephalic arch lesions, ruptures and diffuse access stenoses, are reviewed by Peden[65]. Venous stenosis may become apparent as flow decreases over time, worsening weekly Kt/V or increasing recirculation. CO_2 is a useful contrast agent in the diagnosis and intervention of failing HD access, eliminating or limiting the use of iodinated contrast material. Caution should be exercised to prevent CO_2 reflux into the aorta when injecting the gas into the brachial artery[66].

Arteriovenous grafts: AVGs are the most commonly used type of dialysis access in the United States[67]. However, they do not last as long as AVFs and they have higher rates of infection and thrombosis[68]. Grafts present a second choice of VA when AVF is not possible. AVGs are indicated when superficial veins are unavailable or to repair a nAVF (bridge graft). An AVG is an alternative to tVC if the expected patient survival is long enough to guarantee its clinical benefits[69]. They can be placed in the forearm, the upper arm and the thigh, and can have a straight, curved or loop configuration. They may offer a large surface area for cannulation. AVGs can be cannulated about 2-3 wk after placement, although there are studies suggesting that immediate assessment after placement for PTFE AVGs is possible[70,71]. This interval is needed in order to allow the surrounding tissue to adhere to the PTFE conduit, to reduce the post-surgical edema and the risk for local complications, such as perigraft hematoma and seroma[72].

Arteriovenous graft complications: Functional survival of AVGs is much shorter than AVFs. The natural course of AVGs is thrombosis due to venous stenosis caused by neointimal hyperplasia. The increased production of smooth muscle cells, myofibroblasts and vascularisation within the neointima is the main cause of thrombosis. There are also angiogenesis and numerous macrophages in the tissue around the graft[73,74]. Growth factors such as platelet derived, vascular endothelial and basic fibroblasts are present within the neointimal lesion. Thrombosis of an AVG is usually the result of multiple factors, such as stenosis, hypotension and excessive compression for hemostasis. The risk for thrombosis increases with decreasing blood flow[75]. Treatment with dipyridamole plus aspirin has a significant but modest effect in reducing the risk of stenosis and improving the duration of primary unassisted patency of newly created grafts[76]. Dixon *et al*[77] support that use of aspirin is associated with a trend toward longer primary unassisted patency of newly placed HD grafts, similar to that observed for extended-release dipyridamole plus low-dose aspirin (ERDP/ASA). Daily fish oil ingestion did not decrease the proportion of grafts with loss of native patency within 12 mo, although fish oil improved some relevant secondary outcomes, such as graft patency, rates of thrombosis and interventions[78]. AVGs' infections are serious complications and are the second leading cause of dialysis access loss. The incidence of HD-related bacteremia is more than 10-fold higher in AVGs than AVFs: 2.5 episodes per 1000 dialysis procedures *vs* 0.2[79]. Patients have to be more careful about their hygiene because it seems to be the most important modifiable risk factor[80]. Pseudoaneurysms should be referred to a surgeon for resection when they are > 2 times wider than the graft, rapidly increasing in size or the overlying skin appears under duress (thin, bleeding, blanching)[81]. Ischemia as a result of access placement is more common for AVGs than AVFs: vascular steal syndrome and ischemic monomelic neuropathy are two important clinical entities to distinguish. Endovascular treatment with stent grafts in complicated access, in AVFs as well as in AVGs, aneurysms is a simple, safe and rapid ambulatory procedure that enables treatment of both the aneurysm and its accompanying draining vein stenosis. It enables continued cannulation of the existing access and avoids the use of central catheters[82,83].

Tunneled HD catheter

Tunneled catheters (TC) are used when AVFs or AVGs are not possible to be created for several reasons, such as multiple vascular surgeries which lead to vascular thrombosis or when patients have severe peripheral vascular disease or very low cardiac output. This is more frequently encountered in pediatrics and very old patients. Unfortunately, these are associated with the highest infection rate and they are not a long-term access option. Studies have revealed that CVCs are colonized within 10 d of placement; however, colonization of the catheter biofilm does not correspond to positive blood cultures or clinical signs of bacteremia[84]. It seems that the outcome of the infection treatment does not differ if, in addition to antibiotic therapy, the catheter will be guidewire changed or completely removed[85]. In the Power *et al*[86] study with 759 TCs, the survival rate at 1 year, 2 years and 5 years was 85%, 72% and 48% respectively. The infection rate was 0.34 per 1000 catheter days, showing that with careful and appropriate use of TCs, they can provide effective and adequate long-term HD and rates of access related infection almost similar to AVGs'. When conventional venous accesses have been exhausted and peritoneal dialysis is impossible, it is mandatory to use alternative procedures for VA in order to continue HD. Translumbar inferior vena caval CVCs belong to this category and it seems that they can offer a relatively safe and effective long-term HD access[87]. Another alternative is the transhepatic HD catheters; they seem to be a potentially viable option with low rates of morbidity due to placement, high rates of catheter-related maintenance and the possibility of long-term functionality[88].

MORTALITY AND MORBIDITY OF VASCULAR ACCESS

Studies have shown a mortality risk dependent on access type, with the highest risk associated with central venous dialysis catheters, followed by AVGs and then AVFs[89,90]. Additionally, patients who had a catheter as first VA had more complications and higher mortality[91,92]. Patients who initiate HD with a TC or an AVG have a heightened state of inflammation, which may contribute to the excess 90 d mortality after HD initiation[93]. The CHOICE study examined mortality based on access type in 616 HD patients for up to 3 years of follow-up. CVCs and AVGs were associated with approximately 50% and 26% increased mortality respectively, compared with AVFs with prevalence in men and elderly patients[94,95]. Despite these findings and the K/DOQI recommendations, dialysis access data from 2002-2003 showed that only 33% of prevalent HD patients in the United States were being dialyzed *via* AVFs. On the other hand, in Europe and Canada, the majority of patients (74% and 53% respectively) were being dialyzed *via* AVFs[96]. Pisoni *et al*[97], in a facility-based analyses of DOPPS in order to diminish treatment-by-indication bias, suggest that less catheter and graft use improves patient survival. The high mortality associated at the beginning of HD with CVC (RR: 3.68), independently of other factors, make the decrease in the use of this VA an objective of the first order[98].

Additionally, Wasse *et al*[99] report that levels of self-care and leg effort activity were higher among incident HD patients using an AVF compared to those using a CVC. They also found that compared with persistent CVC use, early persistent AVF use is associated with the perception of improved health status and quality of life among patients with ESRD[100]. The elderly diabetic population with peripheral arteriosclerotic obstructive disease is particularly prone to angio-access induced hand ischemia. In our previous work with 149 HD patients who had undergone 202 VA procedures (177 Cimino-Brescia fistulae and 25 PTFE grafts), we found that the Cimino-Brescia fistula was used as the first choice of VA in all patients except one in the elderly group. PTFE grafts were the second or third choice in 7 patients younger than 65 and 15 in the elderly group. The only reason for technique failure was vascular thrombosis in both groups[8]. Similar reports have been published by Swindlehurst *et al*[101], according to which the creation of permanent HD access in the elderly with AVF is not only possible but also proved to have a short hospital stay, high patency rates and an acceptable rate of further intervention. Desilva *et al*[102] state that, while specific subgroups in the HD population exist where use of fistulas and grafts at time of dialysis initiation is not of proven statistical benefit to survival, elderly HD patients with comorbidities still appear to benefit from the use of fistulas and grafts. Therefore, it is clear that a primary fistula strategy in incident elderly ESRD is feasible and does not result in inferior outcomes. Age should therefore not be a determinant for primary fistula creation[103]. Saxena *et al*[104] state that significantly higher persistent MSSA and MRSA nasal carriage rates among ESRD patients over 75 years of age are suggestive of an elevated risk of potentially serious S. aureus-related complications among the very elderly during long-term HD. These findings might be helpful in the identification of elderly HD patients as a high-risk group for S. aureus-linked VA-related septicemia and to evolve appropriate preventive strategies. However, elderly patients should be considered for angioaccess as first line of venous access. The study by Morsy *et al*[105] showed a successful first dialysis with angioaccess with failure and patency rates comparable to other age groups.

Recently[106], our data are different than what we published in 1998. We found in 189 patients that females were more likely to start HD with a double lumen catheter than males and patients with heart failure were independent of gender. Female patients had PTFE grafts as first VA and the elderly patients had more complications and more VA procedures. Martinez-Gallardo *et al*[107] reported that acute decompensated CHF episodes are common in pre-dialysis CKD patients. In addition to classical risk factors, pre-emptive AVF placement was strongly associated with the development of CHF.

However, Di Iorio *et al*[108] in their cohort study demonstrate that in chronic dialysis patients, CVC choice is associated with significantly increased hospitalization, mortality rate and relative risk of death compared to AVF patients; differences disappeared after correction for comorbidity. Therefore, these data suggest that CVC use *per se* is not associated with increased mortality risks with respect to AVF.

Nephrologists must bear in mind that every VA in the upper limb, lower limb or body wall needs a run-in and a run-off: currently, thrombosis of the central vessels due to the excessive widespread use of CVCs emerge as a substantial cause of HD morbidity and mortality[109]. Gadallah *et al*[110] have presented an unusual case of marked breast enlargement secondary to HD AVF and subclavian vein occlusion proximal to the junction of the mammary vein. A similar case but without subclavian vein occlusion has been presented by Ruiz-Valverde *et al*[111]. Chan *et al*[112] report that obesity was not associated with increased AVF or AVG revision rates or failure and was only associated with poorer AVF maturity at the highest BMI quartile, so it should not preclude placement of AVF as VA of choice, except in the very obese where assessment should be individually based.

In the 2010 USRDS Annual Data Report, hospitalization in 2008 increased again, to a point 46% above their 1993 level. In 2007-2008, women treated with HD were 16% more likely to be hospitalized overall than men. They also had a greater risk than men of cardiovascular, infectious and VA hospitalizations, 11%, 14% and 29% greater, respectively.

There are also causes of morbidity common in all kind of VAs as bacterial spondylodiscitis must be suspected whenever a patient on HD is admitted with fever and/or back pain. The presence of a CVC and a history of multiple vascular accesses may be important risk factors. Prolonged antibiotic therapy with initial broad-spectrum coverage seems to be the best therapeutic approach[113]. Infective endocarditis should be suspected when HD patients suffer from long-term fever, for which prompt blood culture and transthoracic echocardiography confirmation could be performed. Transesophageal echocardiography could be considered even when transthoracic echocardiography produces negative findings. With catheters removed, a full course of appropriate sensitive antibiotics and surgery, if indicated, could improve the outcome of chronic HD patients complicated by infective endocarditis[114].

CONCLUSION

It seems that no evolutionary changes have been observed over the last years concerning VA. According to the guidelines, AVF has to be the first choice of VA when suitable vessels are available. Arteriovenous grafts and CVC may be also a good alternative as first choice when suitable vessels are not available or as a second choice when there is AVF failure. A well matured VA is important for long access survival and early referral to nephrologists is mandatory.

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