REVIEW ARTICLE

Vascular access for hemodialisys: what's new?

Acesso vascular para hemodiálise: o que há de novo?

Milton Alves das Neves Junior[1,2], Alexandre Petnys[1,2], Rafael Couto Melo[1,2], Edgar Rabboni[1,2]

Abstract

The increasing life expectancy of patients with chronic diseases, including chronic renal failure, means that treatment methods are constantly being updated and improved. Long term hemodialysis has created the need to provide and maintain long lasting vascular access. Arteriovenous fistula is the first-choice option for hemodialysis and research has been conducted to attempt to increase the useful life of both fistula and catheter access methods. This article reviews the vascular access options and solutions currently available for hemodialysis.

Keywords: renal dialysis; catheters; arteriovenous fistula.

Resumo

O aumento da expectativa de vida dos portadores de doenças crônicas, entre as quais a insuficiência renal crônica, faz com que métodos de tratamentos estejam em constante aperfeiçoamento. O uso em longo prazo da hemodiálise torna necessário confeccionar e manter acessos vasculares de utilização duradoura. Tanto as fístulas arteriovenosas – primeira opção de acesso para os pacientes hemodialíticos – como os cateteres vêm sendo objeto de estudos na literatura, na tentativa de prolongar sua vida útil. Esta revisão tem como objetivo relatar as alternativas e soluções atuais para os acessos vasculares para hemodiálise.

Palavras-chave: diálise renal; cateteres; fístula arteriovenosa.

[1]Sociedade Brasileira de Angiologia e Cirurgia Vascular – SBACV, São Paulo, SP, Brazil.
[2]Hospital do Servidor Público Municipal – HSPM, São Paulo, SP, Brazil.
Financial support: None.
Conflicts of interest: No conflicts of interest declared concerning the publication of this article.
Submitted on: 07.13.13. Accepted on: 08.07.13.

Study carried out at Hospital do Servidor Público Municipal (HSPM), São Paulo-SP, Brazil.

INTRODUCTION

The number of people with chronic diseases is growing all over the world as populations age. Chronic renal failure (CRF) is responsible for a great deal of morbidity and reduced quality of life. The majority of CRF patients are put on hemodialysis. In Brazil, 89.6% of all dialysis patients are treated in this way[1].

In order to perform hemodialysis, vascular access is needed. Access can be achieved via an arteriovenous fistula, using autogenous or prosthetic vessels, or a venous catheter can be used. Each of these access options has its own indications and restrictions.

The objective of this review of the literature is to present new developments in vascular access, related both to construction and maintenance. Searches were run on the PubMed and Scielo databases for articles published on the subject during recent years, the most relevant of which were selected.

ARTERIOVENOUS FISTULA

This should be the first choice in vascular access for patients with CRF. According to data from the NKF-K/DOQI[2], at least 50% of patients on hemodialysis should be using arteriovenous fistulae (AVF).

Arteriovenous fistulae are indicated in the following circumstances: Serum creatinine over 4.0 mg/dL, Creatinine clearance below 25 mL/min, or when it is forecast that hemodialysis will be needed within twelve months[1], since AVFs require a maturation period before they can be used.

Color Doppler ultrasonography is used to locate the site where access will be created. This type of scan can be used to analyze the venous system for signs of phlebitis, stenosis and occlusions and to assess the artery that will provide the inflow for the AVF. When color Doppler is employed, success rates increase and unsuccessful exploration rates fall[3].

The first choice option is a distal AVF in an upper limb, such as a radiocephalic fistula (Brescia-Cimino), which preserves proximal veins for possible future access requirements[4].

As dialysis treatments extend the life expectancy of these patients, exhaustion of the upper extremity venous system can make it necessary to create exotic AVFs. These can be created using veins from other parts of the body, such as axillo-jugular and axillo–axillary fistulas[5], saphenous vein loops in the lower limbs[6,7], or using grafts, such as in femoro-femoral loops[7] or axillo–axillary necklace bypasses.

Prolongation of AVF use has also increased the number of complications. These can be subdivided into two major groups: infectious and non-infectious.

Infections are relatively rare with autogenous AVFs, but when they occur they have dramatic consequences, involving rupture and profuse bleeding. In the majority of cases, extensive debridement is needed and the fistula must be ligated, and very often the feeder artery will also need ligation to control hemorrhage. Infections are more common when AVFs are created with prosthetic materials. In the absence of bleeding and sepsis, salvage can be attempted using antibiotics. If this is unsuccessful or there is bleeding or sepsis, the prosthesis must be removed and an alternative access created.

Additionally, Gagliardi et al.[8] recently described how cytomegalovirus infection can be linked with failure of AVFs in chronic kidney patients.

Non-infectious complications include stenosis and thromboses, both of which are being studied with great interest in the current literature.

Stenosis can occur along the path of the AVF itself or in central veins. Local stenosis can occur soon after creation or later on. When stenosis occurs earlier, it is most common in the juxta-anastomotic region[9] and may be caused by a technical failure of anastomosis creation, may be due to injury of the vasa vasorum of the dissected portion of the vein, leading to ischemia, fibrosis and failure of the AVF to mature, or even by extrinsic compression (incision wound). Unobserved areas of phlebitis in the body of the vein may also fail to dilate and mature, leading to stenosis. Later stenoses are the result of post-puncture phlebitis or intimal hyperplasia in the anastomosis region or where there is turbulent blood flow.

Treatment of stenosis of the AVF body is by percutaneous balloon angioplasty or surgery. Nassar et al.[9] have reported an 83.2% success rate using balloon angioplasty, with low complication rates (hematoma 15%). However, other articles in the literature advocate placement of stents to increase AVF patency and blood flow[10,11].

When endovascular treatment fails or is not viable, surgery can be used. Spergel et al.[12] have described several surgical technique for correcting stenoses in the body of the AVF. Our department generally employs a vein patch for short stenoses, or resection and interposition of veins of prostheses for longer stenoses.

Stenoses of central veins primarily occur in the subclavian vein. They are most common when central catheters have been used, but may also occur 'spontaneously'. There is an anatomic detail that is of fundamental importance to understanding this phenomenon: the subclavian vein rests on the first rib. This means that the endothelium can be injured by a catheter in this position or even by high flows generating thrill associated with respiratory movements, the ultimate consequence of which is stenosis of the vein.

The great majority of stenoses of the subclavian vein are corrected with percutaneous angioplasty using the AVF or the femoral vein for access. Placement of stents in this position remains controversial. Kim et al.[13] have reported that angioplasty restenosis rates are similar with and without stents. Kwok[14] recommends that stents should be reserved for cases of recoil or restenosis within 3 months of angioplasty.

Thrombosis of an AVF demands urgent vascular treatment to salvage access. It may be caused by hypotension, excessive post-puncture compression, compressive hematoma or prior stenoses restricting blood flow.

Thromboses can be treated using surgery or percutaneous procedures. Surgery involves a direct approach to the AVF and thrombectomy with a Fogarty catheter. This reestablishes flow, but the underlying cause of thrombosis should also be treated (drainage of hematoma, repair of stenosis).

Percutaneous treatment starts with thrombolysis, using thrombolytic drugs such as urokinase or r-tpa. Cho et al.[15] have reported successful treatment of thrombosis of AVFs using pharmacomechanical thrombolysis with pulse-spray catheters and urokinase. If stenosis is found, this should be corrected with angioplasty, as described above.

These procedures make it possible to salvage access, helping to avoid exhaustion of the superficial venous system in the long term, and the resulting need to employ central venous catheters.

CENTRAL VENOUS CATHETERS

Central venous catheters are indicated in urgent hemodialysis cases or when an AVF cannot be created. In dialysis patients they are linked with higher rates of infection, hospitalization, morbidity and mortality[16].

The jugular veins are the site of choice because complications are less common. The second choice location is the femoral and subclavian veins.

We often encounter patients in whom access for catheter placement is difficult to obtain because of thrombosis in the sites mentioned above. This is a major challenge for the treating surgeon because it obliges placement of catheters in non-standard locations.

One alternative is placement in the inferior vena cava using translumbar puncture with a 20 cm needle. Entry is via the right paravertebral space (displaced 10 cm laterally from the vertebral body and 1.5 cm above the iliac spine) and the catheter tip is positioned at the inferior atriocaval junction[17].

Another alternative is catheter placement via transparietal-hepatic puncture. Here the puncture is made with a Chiba needle through the right tenth intercostal space in a postero-superior direction and the hepatic vein is located using fluoroscopy. A guide-wire is then used to direct the catheter along the suprahepatic vein to the right atrium[18,19].

Recently, Menezes et al.[20] conducted a study with an animal model in which a catheter was placed in the superior vena cava via the azygos vein using thoracoscopy. The catheter is thus placed at the point that the superior vena cava flows into the right atrium. Depending on the results of future clinical trials, this route may be adopted as a new alternative for catheter placement.

Another major challenge is maintenance of catheters. The need to keep them patent and free from infections means that research into new formulations for lock solutions is constant.

As a routine, catheters are filled with heparin after use to avoid the formation of thrombi in their interiors, thereby reducing the frequency of infection and occlusions.

The ideal heparin dosage has become a cause of disagreement in the literature. Thomson et al.[21] report that using 1000 UI/mL heparin involves reduced risk of systemic heparinization than the usual 5000 UI/mL dosage, without increasing rates of infection, catheter loss or malfunction. However, Ivan et al.[22] used the same concentrations of heparin and showed that although catheter patencies were similar in both groups, the group given 1000 UI/mL needed twice the volume of thrombolytics infused to deobstruct catheters. At our department, routine procedure is to fill catheters with heparin 5000 UI/mL.

Lock solutions containing antibiotics and thrombolytics are also under study in the hope that they can reduce the rates of catheter-related infections in dialysis patients. Maki et al.[23] have described a multicenter study in which a solution containing 0.24 M (7.0%) sodium citrate, 0.15% methylene blue, 0.15% methylparaben and 0.015% propylparaben (C-MB-P) was compared with heparin, reporting a significant reduction in catheter-linked infection rates. Campos et al.[24] have reported similar results using a solution containing minocycline and EDTA.

FINAL COMMENTS

Hemodialysis vascular access techniques continue to be improved and recent studies such as those described above demonstrate a wide range of options for creation and maintenance of access. Notwithstanding, dialysis services must be constantly vigilant to ensure rational use and care of the venous systems of chronic kidney patients in order to avoid complications and extend the length of time they can be used.

REFERENCES

1. Neves MA Jr, MeloII RC,Almeida CC, et al. Avaliação da perviedade precoce das fistulas para hemodiálise. J Vasc Bras. 2011;10(2):105-9.
2. Vascular Access Work Group. Clinical Practice Guidelines for Vascular Access: update 2006. Am J Kidney Dis. 2006;48(1):S177-247.
3. Robbin ML, Gallichio MH, Deierhoi MH, Young CJ, Weber TM, Allon M. US Vascular Mapping before Hemodialysis Access Placement. Radiology. 2000;217:83-8. PMid:11012427.
4. Srivastava A, Sharma S. Hemodialysis vascular access options after failed Brescia-Cimino arteriovenous fistula. Indian J Urol. 2011;27(2):163-8. PMid:21814303 PMCid:PMC3142823. http://dx.doi.org/10.4103/0970-1591.82831
5. Hazinedaroğlu S, Karakayali F, Tüzüner A, et al. Exotic arteriovenous fistulas for hemodialysis. Transplant Proc. 2004;36(1):59-64. PMid:15013301. http://dx.doi.org/10.1016/j.transproceed.2003.11.067
6. Pierre-Paul D, Williams S, Lee T, Gahtan V. Saphenous vein loop to femoral artery arteriovenous fistula: a practical alternative. Ann Vasc Surg. 2004;18(2):223-7. PMid:15253260. http://dx.doi.org/10.1007/s10016-004-0016-7
7. Antoniou GA, Lazarides MK, Georgiadis GS, Sfyroeras GS, Nikolopoulos ES, Giannoukas AD. Lower-extremity arteriovenous access for haemodialysis: a systematic review. Eur J Vasc Endovasc Surg. 2009;38(3):365-72. PMid:19596598. http://dx.doi.org/10.1016/j.ejvs.2009.06.003
8. Gagliardi GM, Rossi S, Condino F, et al. Malnutrition, infection and arteriovenous fistula failure: is there a link? J Vasc Access. 2011;12(1):57-62. PMid:21038306. http://dx.doi.org/10.5301/JVA.2010.5831
9. Nassar GM, Nguyen B, Rhee E, Achkar K. Endovascular Treatment of the "Failing to Mature" Arteriovenous Fistula. Clin J Am Soc Nephrol. 2006;1:275-80. PMid:17699217. http://dx.doi.org/10.2215/CJN.00360705
10. Chan MR, Bedi S, Sanchez RJ, et al. Stent placement versus angioplasty improves patency of arteriovenous grafts and blood flow of arteriovenous fistulae. Clin J Am Soc Nephrol. 2008;3(3):699-705. PMid:18256373 PMCid:PMC2386706. http://dx.doi.org/10.2215/CJN.04831107
11. Hatakeyama S, Toikawa T, Okamoto A, et al. Efficacy of SMART Stent Placement for Salvage Angioplasty in Hemodialysis Patients with Recurrent Vascular Access Stenosis. Int J Nephrol. 2011;2011:464735.
12. Spergel LM, Ravani P, Roy-Chaudhury P, Asif A, Besarab A. Surgical salvage of the autogenous arteriovenous fistula. J. Nephrol 2007;20:388-98. PMid:17879203.
13. Kim YC, Won JY, Choi SY, et al. Percutaneous treatment of central venous stenosis in hemodialysis patients: long-term outcomes. Cardiovasc Intervent Radiol. 2009;32(2):271-8. PMid:19194745. http://dx.doi.org/10.1007/s00270-009-9511-0
14. Kwok PC. Endovascular Treatment for Central Venous Stenosis due to Central Vein Catheterization for Hemodialysis. Saudi J Kidney Dis Transpl. 2004;15(3):338-45. PMid:18202484.
15. Cho SK, Han H, Kim SS, et al. Percutaneous treatment of failed native dialysis fistulas: use of pulse-spray pharmacomechanicalthrombolysis as the primary mode of therapy. Korean J Radiol. 2006;7(3):180-6. PMid:16969047 PMCid:PMC2667599. http://dx.doi.org/10.3348/kjr.2006.7.3.180
16. Ortega T, Ortega F, Diaz-Corte C, et al. The timely construction of arteriovenous fistulae: a key to reducing morbidity and mortality and to improving cost management. Nephrol Dial Transplant. 2005;20(3):598-603. PMid:15647308. http://dx.doi.org/10.1093/ndt/gfh644
17. Kade G, Leś J, Grzesiak J, et al. Translumbar inferior vena cava cannulation. Anestezjol Intens Ter. 2010;4:184-6.
18. Nasser F, BiagioniII RB, Campos RCA, et al. Relato de caso: implante transparietohepático de cateter de longa permanência para diálise. J Vasc Bras. 2007;6(4):391-4. http://dx.doi.org/10.1590/S1677-54492007000400014
19. Motta-Leal-Filho JM, CarnevaleII FC, Nasser F, et al. Acesso venoso trans-hepático percutâneo para hemodiálise: uma alternativa para pacientes portadores de insuficiência renal crônica. J Vasc Bras. 2010;9(3):131-13. http://dx.doi.org/10.1590/S1677-54492010000300006
20. Menezes FH, Rielli G, Dion YM. Thoracoscopic transpleural azygos vein cannulation as vascular access for hemodialysis: experimental study in a porcine model. Surg Laparosc Endosc Percutan Tech. 2010;20(3):e79-83. PMid:20551799. http://dx.doi.org/10.1097/SLE.0b013e3181dc35be
21. Thomson PC, Morris ST, Mactier RA.The effect of heparinized catheter lock solutions on systemic anticoagulation in hemodialysis patients. Clin Nephrol. 2011;75(3):212-7. PMid:21329631. http://dx.doi.org/10.5414/CN106460
22. Ivan DM, Smith T, Allon M. Does the heparin lock concentration affect hemodialysis catheter patency? Clin J Am Soc Nephrol. 2010;5(8):1458-62. PMid:20498241 PMCid:PMC2924411. http://dx.doi.org/10.2215/CJN.01230210
23. Maki DG, Ash SR, Winger RK, Lavin P; AZEPTIC Trial Investigators. A novel antimicrobial and antithrombotic lock solution for hemodialysis catheters: a multi-center, controlled, randomized trial. Crit Care Med. 2011 Apr;39(4):613-20. PMid:21200319. http://dx.doi.org/10.1097/CCM.0b013e318206b5a2
24. Campos RP, Do Nascimento MM, Chula DC, Riella MC. Minocycline-EDTA lock solution prevents catheter-related bacteremia in hemodialysis. J Am Soc Nephrol. 2011;22(10):1939-45. PMid:21852579 PMCid:PMC3279952. http://dx.doi.org/10.1681/ASN.2010121306

Correspondence
Milton Neves Junior
Hospital do Servidor Público Municipal (HSPM)
Serviço de Cirurgia Vascular
Rua Castro Alves, 60, Secretaria do 5º andar, Liberdade
CEP 01532-400 - São Paulo (SP), Brasil
Fone: (11) 33978005
E-mail: miltonanj@yahoo.com.br

Author information
MANJ, AP and RCM hold a Lato Sensu degree in vascular surgery from Sociedade Brasileira de Angiologia e Cirurgia Vascular (SBACV) and are vascular surgeons at Hospital do Servidor Público Municipal (HSPM).
ER holds a Lato Sensu degree in vascular surgery from Sociedade Brasileira de Angiologia e Cirurgia Vascular (SBACV) and is chief of the Vascular Surgery Service of Hospital do Servidor Público Municipal (HSPM).

Author's contributions
Conception and design: MANJ, AP, RCM, ER
Analysis and interpretation: MANJ, AP, RCM, ER
Data collection: MANJ, AP, RCM, ER
Writing the article: MANJ, AP
Critical revision of the article: MANJ, AP, RCM, ER
Final approval of the article*: MANJ, AP, RCM, ER
Statistical analysis: N/A
Overall responsibility: MANJ
Obtained funding: None.

*All authors should have read and approved of the final version of the article submitted to J Vasc Bras.