CASE REPORT

Title

Angioplasty in CKD patients with immature AV fistula: A Case Report

Authors:

Atma Gunawan , Sulih Yekti Ngutamani, Achmad Rifai, Nursamsu
Division of Nephrology and Hypertension, Department of Internal Medicine
Faculty of Medicine Universitas Brawijaya, Malang, Indonesia

Editor:

Anil Agarwal

Received 28 February 2019, revised 1 July 2019, accepted 31 July 2019, published 1 August 2019

Background

Abstract

Arteriovenous fistula has been preferred to other vascular access for dialysis due to better patient outcome for morbidity and mortality. However, AVF failure is quite prevalent. One of the cause for AVF failure is due to venous stenosis, diagnosed through Doppler ultrasound and venography. Angioplasty is one of the methods that can be used to repair and salvage an immature AVF. In this report, a 59 year old female patient was diagnosed with CKD with a long history diabetes mellitus type 2 and admitted for routine hemodialysis. An AVF was created on her left radiocephalic vein, and upon evaluation was found to not mature properly. Doppler ultrasound examination showed fistula diameter of 3 mm and volume flow of 160 ml/min, whereas venography showed stenosis in radiocephalic fistula. Balloon angioplasty was then performed with balloon diameter of 4 mm and balloon pressure of 10, 15, and 20 atm for three minutes each. After the procedure, the fistula exhibit dilatation with minimum residual stenosis and adequate as vascular access for hemodialysis.

Keyword: vascular access, hemodialysis, venous stenosis, AV fistula, angioplasty

Corresponding author:

A. Gunawan, e-mail: atmagunawan2010@yahoo.com

Patients with end-stage chronic kidney disease (CKD) must undergo renal replacement therapy, such as hemodialysis. With chronic hemodialysis, patients must have proper vascular access; arteriovenous fistula (AVF) is the preferred type of access due high prevalence of infection and other complications and mortality for central venous catheter (CVC).¹ Compared to arteriovenous graft (AVG), AVF provided longer lasting patency and lower morbidity and mortality.² There are three aspects in the establishment of an AVF, which are AVF surgery, AVF maturation, and AVF function.³ The surgical procedure for AVF involves the anastomosis of the selected vein to adjacent artery.³ The maturation of AVF is evaluated using the rule of 6; after 4-6 weeks, diameter of 6 mm, less than 6 mm distance from body surface, and flow of over 600 ml/min.³ The success of AVF function is then evaluated through its ability to be used as dialysis vascular access and repeated cannulation.³ Primary AVF failure is defined as AVF that cannot be used or failed to be used as hemodialysis vascular access under 3 months post-surgery. Risk factors for primary AVF failure is advanced age, obesity, female gender, diabetes with or without peripheral arterial disease or coronary disease, and of African descent.^{4,5,6} The management of venous stenosis in AVF failure can be done through surgical procedure or percutaneous intervention. Percutaneous intervention has the advantage of lower risk of complication compared to surgical procedures; however, there's still 15% risk of restenosis.^{7,8}

Case Illustration

A 59 year-old female patient was admitted with end-stage renal disease for 6 months and type 2 diabetes mellitus (T2DM). Patient had had T2DM for 20 years and blood glucose was controlled with oral anti-diabetics and switched to basal insulin three years ago. Immediately after diagnosed with ESRD, the patient had central vein access for dialysis. The patient had underwent surgery for left radiocephalic AVF 5 months prior, however upon examination using Doppler ultrasound the diameter of the fistula was 3 mm and the blood flow was 160 ml/minute, not adequate as a vascular access. The patient was then planned to have venography and angioplasty.

Figure 1. Doppler ultrasound imaging of AVF prior to angioplasty

Before the procedure, patient fasted for 4 hours and anti-hypertensive medications was administered as scheduled. The venography and angioplasty procedure was performed using local anesthesia. The procedure started with the insertion the venous segment of the AVF using intravenous cannula Abbocath 18 G. Afterwards, RADIOFOCUS™ Guidewire M 0.035 “ (0.89 mm) 50 cm was introduced through the cannula and aimed at the stenosis. After the cannula was released, PRELUDE® sheath introducer 6 French 11 cm was inserted through the guidewire. After the introducer was properly inserted, the guidewire was removed and the introducer was fixated. Contrast was then administered to visualize the lesion, which was a stenosis in the proximal venous limb adjacent to the fistula.

RADIOFOCUS™ Guidewire M 0.035 “ (0.89 mm) 150 cm was then inserted through the introducer sheath until it passed the location of stenosis. Balloon angioplasty using Boston scientific MUSTANG™ 4.0 mm x 40 mm 135 cm was inserted over guide wire and the

balloon segment was placed in the middle of the lesion. Balloon dilatation was done with the pressure of 10 atm, 15 atm, and 20 atm, 3 minutes each.

Figure 2. Venography images prior to angioplasty

Figure 3. Baloon dilatation using a) 10 atm, b)15 atm, and c) 20 atm pressure

Figure 3. Venography post angioplasty.

Post angioplasty Doppler evaluation showed volume blood flow of 200 ml/min and venous diameter was 4 mm. Four weeks after the procedure, the AVF was evaluated clinically and showed dilated vein diameter with adequate thrill. When used as a vascular access for hemodialysis, the AVF produced Qb of 250 ml/min and the patient managed to achieve KT/V of 1.3.

Discussion

The patient had increased risk for AVF failure due to age, gender, and 20 years of T2DM.^{9,10} The use of Doppler ultrasound and venography was enough to provide the information needed for percutaneous angioplasty procedure, for these imaging modalities were proven to be economically efficient and clinically sensitive and effective.¹¹ The balloon should be 20-30% larger than the normal vessel diameter judged by comparison with the vessel lumen adjacent to the lesion. The use of balloon with 4-8 mm diameter was deemed appropriate for the AVF stenosis. The balloon for radiocephalic fistula is usually 4-6 mm.⁸ When procedure was performed, in the radiology cathlab only available is a 4 mm

diameter balloon catheter. But because this was a primary failure, where the AV shunt failed to mature, the dilation of the stenotic lesion was expected to make the outflow segment further dilated. A month afterwards the AV shunt matured and produced Qb of 200 ml / minute on the HD machine, despite being below 600 ml/min this blood flow was adequate for patient's KT / V target of 1.3. The pressure administered for angioplasty ranges from 5 atm to 40 atm with mean pressure below 20 atm.¹² Although according to previous studies there's no significant difference between the duration of 1 minute and 3 minutes of pressure time, 3 minutes was used to ensure adequate dilatation.¹³

The National Kidney Foundation (NKF/KDOQI) recommends the threshold of over 30% for post-procedural restenosis to be deemed as failure of angioplasty. In this case, the restenosis was minimal and thus the AVF managed to provide adequate diameter and blood flow for vascular access 4 weeks after the procedure.

This case might be a usual procedure in the case of AV shunt stenosis. However, this procedure is quite uncommon in Indonesia, especially in areas with limited access to necessary equipment for the procedure. Hopefully this case will encourage clinicians and stakeholders to embrace a new era of developing endovascular interventions for AV shunts in Indonesia.

Summary

A 59-year-old woman was diagnosed with end-stage CKD with failing AVF due to stenosis in the proximal venous limb of the left radiocephalic fistula. Angioplasty was then performed to repair the stenosis using 4 mm balloon dilatation with 10, 15, and 20 atm pressure, 3 minutes each. After the procedure, the fistula exhibit minimal restenosis. Upon evaluation 4 weeks after the procedure, the fistula showed clinically dilated vein and adequate thrill. The fistula produced Qb of 250 ml/min and the patient managed to achieve KT/V of 1.3.

References

1. Santoro, D., Benedetto, F., Mondello, P., Pipitò, N., Barillà, D., Spinelli, F., & Buemi, M. Vascular Access for Hemodialysis: Current Perspectives. *Int J Nephrol Renovasc Dis.* 2014 Jul 8;7;281-94.
2. Allon, M., & Robbin, M. L. Increasing Arteriovenous Fistulas in Hemodialysis Patients: Problems

- and Solutions. *Kidney Int.* 2002 Oct; 62(4); 1109-24.
3. Donnelly, S. M., & Marticorena, R. M. When is A New Fistula Mature? The Emerging Science of Fistula Cannulation. *Semin Nephrol.* 2012 Nov; 32(6); 564-71
 4. Miller, P. E., Tolwani, A., Luscy, C. P., Deierhoi, M. H., Bailey, R., Redden, D. T., & Allon, M. Predictors of Adequacy of Arteriovenous Fistulas in Hemodialysis Patients. *Kidney Int.* 1999; 56(1); 275-80.
 5. Monroy-Cuadros, M., Yilmaz, S., Salazar-Bañuelos, A., & Doig, C. Risk Factors Associated with Patency Loss of Hemodialysis Vascular Access within 6 months 2010 Oct; 5(10): 1787–1792.
 6. Al-Jaishi, A. A., Oliver, M. J., Thomas, S. M., Lok, C. E., Zhang, J. C., Garg, A. X., & Moist, L. M. Patency Rates of The Arteriovenous Fistula for Hemodialysis: A Systematic Review and Meta-analysis. *Am J Kidney Dis.* 2014 Mar; 63(3); 464-78
 7. Beathard, G. A. Percutaneous Transvenous Angioplasty in The Treatment of Vascular Access Stenosis. *Kidney Int.* 1992;42(6); 1390-7.
 8. Trerotola, S. O., Kwak, A., Clark, T. W., Mondshein, J. I., Patel, A. A., Soulen, M. C., & Chittams, J. L. Prospective Study of Balloon Inflation Pressures and Other Technical Aspects of Hemodialysis Access Angioplasty. *J Vasc Interv Radiol.* 2005 Dec;16(12):1613-8.
 9. 15. Marcus, R. J., Marcus, D. A., Sureshkumar, K. K., Hussain, S. M., & McGill, R. L. Gender Differences in Vascular Access in Hemodialysis Patients in The United States: Developing Strategies for Improving Access Outcome. *Gend Med.* 2007 Sept;4(3);193-204.
 10. Davidson, I., & Gallieni, M. (2015). Optimizing Vascular Access in The Elderly: Words We Use Affect Patient Care. *J Vasc Acc.* 2015; 16(6); 437-8.
 11. Beathard, G. A. Physical Examination of The Dialysis Vascular Access. *Semin Dial.* 1998 Jul;11(4); 231-6)
 12. Vesely, T. M., & Pilgram, T. K. Angioplasty Bal-
 - loon Inflation Pressures during Treatment of Hemodialysis Graft–Related Stenoses. *J Vasc Interv Radiol.* 2006;17(4); 623-628.
 13. Forauer, A. R., Hoffer, E. K., & Homa, K. Dialysis Access Venous Stenoses: Treatment with Balloon angioplasty—1-versus 3-Minute Inflation Times. *Radiol.* 2008;249(1); 375-81.