Archives of Radiology

ISSN: 2638-521X

Volume 3, Issue 1, 2020, PP: 14-17

Ultrasound of a Failed Proximal Radial Artery-Cephalic Vein Arteriovenous Fistula

Amarjit Singh, Ph.D, RDMS, RDCS, RVS, ASAR[1], D.K. Bobra, MD[2]

[1]Department of Radiology, USPHS Indian Health Service Chinle Hospital, Chinle, Arizona 86503, USA.

[2]Vascular Surgical Associates, 2050 E Southern Avenue, Suite A, Tempe Arizona 85282, USA.

Amarjit.Singh@ihs.gov

***Corresponding Author:** Amarjit Singh Ph.D., RDMS, RDCS, RVS, ASAR, Department of Radiology, USPHS Indian Health Service Chinle Hospital, Chinle, Arizona 86503, USA.*

Abstract

The most common cause of vascular access failure is thrombosis. In AVF thrombotic occlusion oftenoccur early due to inadequate flow resulting from small lumen of vessels or failure to dilate. Once AVFis matured thrombosis is rare. We report a unique case of a matured AVF, which was functioning normally, that failed after a successful dialysis. The cause of the failure was not due to thrombosis or venous hypertension but due to a large hematoma formed under the cephalic vein which then pushed the draining vein to close. The hematoma was likely caused by the perforation of the vein at both ends during cannulation.

Keywords: *AVF, hemodialysis, radial artery, cephalic vein, ultrasound*

Introduction

Patients with end-stage renal disease (ESRD) require permanent vascular access for hemodialysis. Thisis obtained by constructing arteriovenous fistula (AVF) or using a synthetic polytetrafluoroethylene(PTFE) graft. The most common AVF (Brescia-Cimino)[1] is constructed at the wrist, between the radialartery (RA) and the cephalic vein (CV) that provides permanent vascular access. It is preferred becauseof the durability, low risk of complication[2]and high patency rates[3]. Both the fistulas (AVF) andprosthetic grafts are associated with a wide range of problems that threatens the vascular access. Themost common complications in fistulas are lack of patency, failure of maturation, and insufficient flowthrough dialysis. The success of the AVF surgery requires good arterial volume flow greater than 200ml/min, patency and good distension of the vein[3]. However, in patients with previously failed fistulas inthe distal forearm or in diabetics in whom there is occlusive distal disease of the radial artery, proximal radial artery and cephalic vein fistula is preferred for hemodialysis[4]. AVF can fail due to any number ofreasons that include thrombosis, infection, false aneurysm formation, venous hypertension producing limb edema, and arterial steal syndrome producing hand ischemia and occlusion of the anastomosis

Case Report

In this case report, we are presenting a rare case of a proximal radial-cephalic vein AVF which had agood arterial volume flow of 350 ml/min at maturation and was successfully being used for hemodialysis for the past 6 months but abruptly failed after a successful dialysis. The volume flow Q at the time of maturation in the present studywas calculated using the equation

$$Q = TVA\ \pi\ r^2 \times 60\ ml / min$$

TVA is the time averaged velocity (cm/s) of flow in the feeding artery obtained in longitudinal planewith a Doppler angle at 60°and r is the radius in cm.

The proximal radial and cephalic vein AVF was surgically constructed by one of the author (DKB). After six months of successful dialysis it suddenly closed after a dialysis session. There was not sufficient

access volume flow to carry outhemodialysis and the patient complained of swelling and pain in the arm and around the site of the AVF.It was thought that the vein had developed thrombosis. Before any invasive intervention, likeangioplasty, be done to restore functional patency and extend access survival the patient was referred toour clinic for evaluation. Ultrasound study was performed on a HP SONOS 5500 ultrasound machineusing a standard linear array vascular probe. The non-dominant forearm in which the fistula wasconstructed was assessed by placing the patient's arm in a comfortable position on towels on top of aprocedure stand. Using minimal pressure and abundant ultrasound gel, the feeding artery – proximalradial, arteriovenous anastomosis, and the draining cephalic vein, was thoroughly evaluated for anythrombosis leading to stenosis. The entire draining vein was scanned in the transverse plane and itsdiameter measured in the caudal, mid, and cranial portion of the arm. The feeding artery was scannedcephalic to the point of anastomosis and distal in the gray scale and using color Doppler. There was nostenosis in the feeding artery and at the anastomosis. The anastomosis was patent and measured 2.4 mm.The draining vein was sufficiently distended and measured 6 mm upstream proximal to the anastomosis.Color Doppler did not display adequate flow volume proximal in the draining vein, but further distal tothe anastomosis the lumen of the vein became narrower (> 90%) and appeared closed, thus obstructingthe blood flow. Figure 1 shows the narrowing of the lumen of the draining vein in the longitudinal plane.

A dark anechoic area under the vein was noticed in the longitudinal plane at the cannulation site. Thepool of blood under the cephalic vein collected to form hematoma which exerted sufficientpressure on the vein to narrow the lumen. The narrowing of the lumen due to the existing hematomaunder the vein is shown in Figure 2. It can be noticed from the color flow that the lumen is 90% closed.This reduces the access volume flow (ml/min) to a point that the fistula failed to perform hemodialysis.

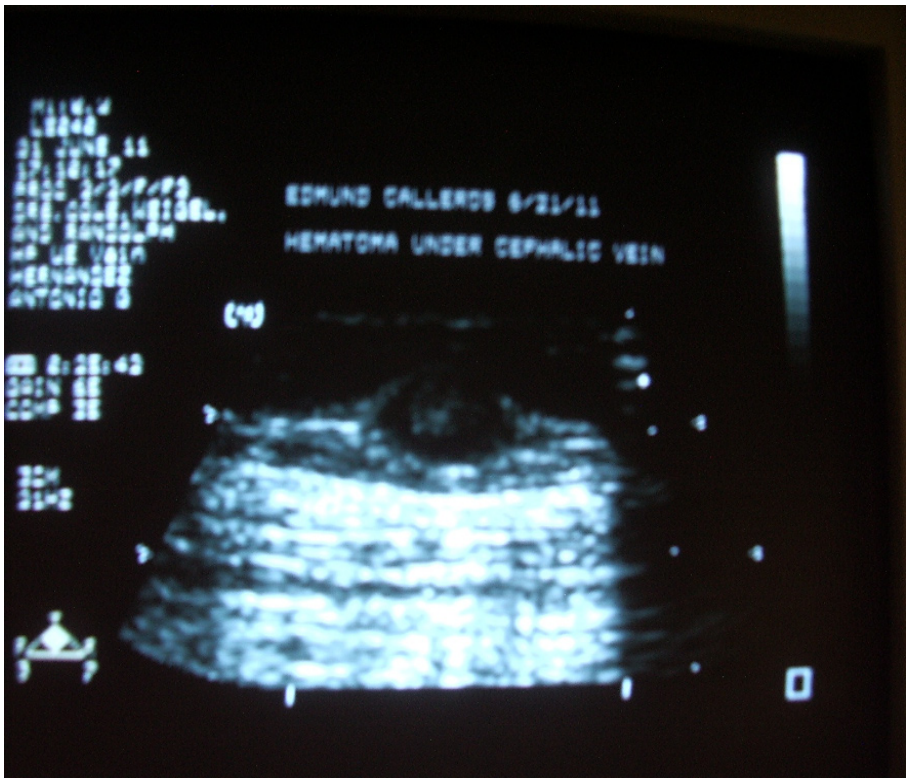

Figure1. *Ultrasound image of the draining cephalic vein in the longitudinal plane. The hypoechoic mass with internal echoes is hematoma under the vein that has pushed the vein to close.*

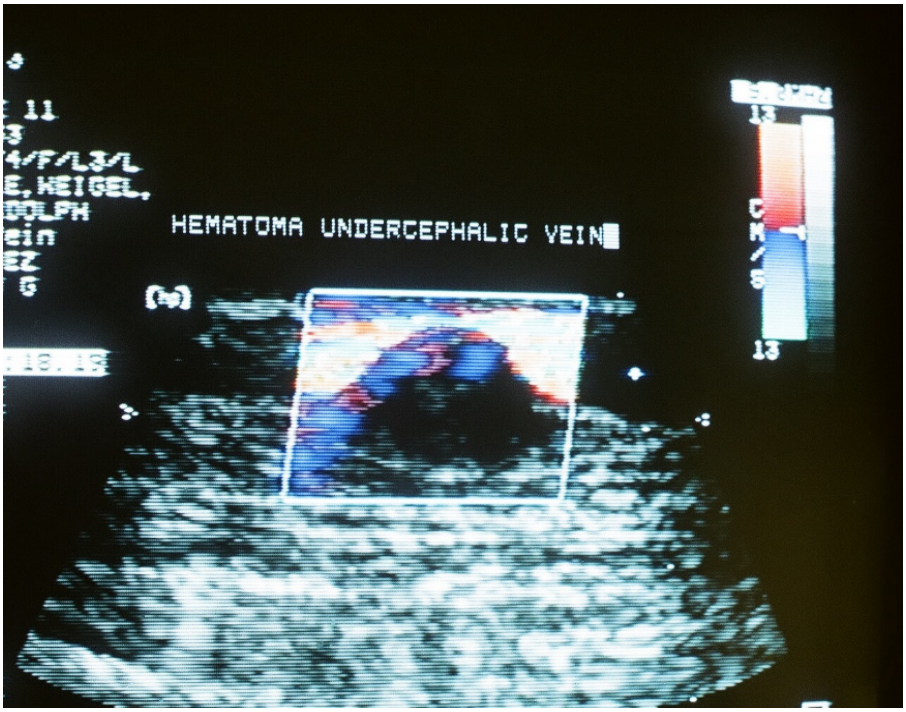

Figure2. *Ultrasound image of the draining cephalic vein in the longitudinal plane with color flow. The hypodense mass with internal echoes is hematoma. Notice the narrowing of internal lumen of the vein thus decreasing the volume of flow.*

Discussion

Stenosis in the AVFs tends to be located more centrally in the outflow tract and is caused by bifurcationof the vein or by venous valves. The most common cause of vascular access failure is thrombosis. Graftstenosis usually develop in the venous outflow tract at the site of anastomosis between the graft and thevein. In contrast to grafts, thrombotic occlusions of AVFs often occur early because of inadequate flowresulting from small lumen of vessel or failure to dilate. Once AVFs are fully matured thrombosis israre[5]. In the present case the AVF was fully matured and functioning with good access volume flow. Sowhat could be the reason for the abrupt failure of AVF? There was no past history of low delivered doseof dialysis or cannulation problem, pain or elevated venous inflow pressure that would raise clinicalsuspicion of stenosis. Access volume flow (ml/min) is the most significant predictor of accessdysfunction both in fistulas and grafts[6,7]. Although there is controversy regarding the threshold accessvolume flow to predict AVF failure. Fistulas generally remain patent at considerably lower flow thangrafts[5]. In fistulas an access flow higher than 300 ml/min is usually required to deliver an adequate doseof hemodialysis without recirculation problems[5]. Thus the access flow of 350 ml/min in the present casewas adequate and cannot be considered a risk for the failure of the fistula. In PTFE grafts, thresholdaccess flow rates less than 500–800 ml/min are associated with a significantly increased risk of failure[6, 8].Aneurysms and pseudo-aneurysms usually develop at sites of vessel destruction after repeatedcannulation[8], but in this case there was no evidence of either thrombosis related stenosis or pseudo-aneurysm in thedraining vein or at the site of cannulation. Furthermore, color Doppler flow imaging can especiallydistinguish pseudo-aneurysms from hematoma, showing the so called 'to-and-fro' sign, a typicalwaveform characterized by the backflow of blood from the aneurysmal sac into the original vessellumen during diastole, which was absent in the present case, as seen in color Doppler (Fig. 2). Thelocation of the hematoma is under the vein at the cannulation site. It is very likely that the vein may have

beenaccidentally perforated at the both ends by 15 gauge needle during cannulation, whichlead to prolong bleeding creating a pool of blood to accumulate under the vein forming hematoma. Overthe period of few days it became a solid mass thus putting pressure on the vein to close. One of theauthors (DK) removed the solid hematoma surgically thus restoring the patency of the draining vein.Ultrasound confirmed a thrill in the draining vein and a good access flow. Thus the failure of the fistula was not due to thrombosis or segmental stenosis, occlusion of the anastomosis or due to pseudo-aneurysm, but due to the formation of a large hematoma at the cannulation site, which is somewhat rather unique.

Reference

[1] Brescia MJ, Cimino JF, Appel K, Hurwigh BH. Chronic hemodialysis using venipuncture in a surgically created arteriovenous fistula. N Engl J Med 1956;275:1089-92.

[2] Malovrh M. Non-invasive evaluation of vessels by duplex sonography prior to construction ofarteriovenous fistulas for hemodialysis. Nephrol Dial Transplant 1998; 13:125.

[3] Gibson KD, Gillen Dl, Caps MT et al. vascular access survival and incidence of revision: a comparison of prosthetic grafts,simpleautogenous fistulas,and venous transposition fistulas fromthe United States Renal Data System Dialysis Morbidity and Mortality study. J VascSurg 2001;34: 694.

[4] Toledo-Pereyra LH, Kyriakides GK, Ma KW, et al. Proximal radial artery-cephalic vein fistulahemodialysis, Arch Surg. 1977; 112: 226.

[5] Wise P, Nonnast-Daniel B, Color Doppler ultrasound in dialysis access. Nephrol Dial Transplant. 2004; 19: 1956.

[6] Lok CE, Bhola C, Croxford R, et al. Reducing vascular access morbidity a comparative trial oftwo vascular access monitoring strategies. Nephro Dial Transplant 2003; 18: 1174.

[7] May RE, Himmelfrab J, Yenicesu M, et al. Predictive measure of vascular access thrombosis: aprospective study. Kidney Int. 1997; 52: 1656.

[8] Bay WH, Henry ML, Lazarus JM, et al. Predicting hemodialysis access failure with color flow Doppler ultrasound. Am J Nephrol 1998; 18: 296.

Citation: **Amarjit Singh, D.K. Bobra**. *Ultrasound of a Failed Proximal Radial Artery-Cephalic Vein Arteriovenous Fistula. Archives of Radiology. 2020; 3(1): 14-17.*