

# Prospective study of 51 patients with immediate or early malfunction of long-term hemodialysis catheters

Ahmed M.T. Ghanem<sup>(1)</sup>, MRCS; Amira R. El Tabbakh<sup>(2)</sup>, M.Sc;  
Tarek A. Abdel Azim<sup>(3)</sup>, MD, FRCS

(1) Department of Vascular Surgery, Nasser Institute for Research & Treatment, Cairo.

(2) Department of Radiology, Tanta University, Tanta.

(3) Department of Vascular Surgery, Ain-Shams University, Cairo.

**Introduction:** Long-term dialysis catheters provide an important access for hemodialysis for patients with end-stage renal disease. They are however associated with a significant incidence of early malfunction. The present study aims at identifying the various causes of long term dialysis catheter early malfunction as well as the accuracy of the currently used diagnostic modalities for assessment of such causes.

**Patients and methods:** 51 patients (24 males 27 females, mean age 64.6 years) with early long term dialysis catheter malfunction were included in the study. All patients were evaluated by duplex ultrasonography and magnetic resonance venography (MRV) and results of the two diagnostic modalities were compared.

**Results:** Both duplex scan and MRV demonstrated central venous thrombosis in 4 patients (7.8%). Central venous attenuation or stenosis secondary to previous catheter insertion was identified in 13 cases (25.5%) by MRV but was only detected in 3 cases (5.9%) by duplex ultrasonography ( $p > 0.001$ ).

**Conclusion:** Causes of catheter malfunction in the present study included malposition, intra or peri-catheter thrombosis, and central vein attenuation or stenosis. While duplex scan and MRV were equally accurate in detection of central venous thrombosis, MRV was much more sensitive in detection of central vein attenuation or stenosis. We recommend the wider use of MRV for investigating patients with early malfunction of such dialysis catheters as well as for preoperative evaluation of patients with previous catheter insertion.

**Key words:** Dialysis catheters – MR venography – Vascular access.

## Introduction:

Hemodialysis requires repeated, secure access to the blood stream whilst ensuring an adequate rate of blood flow. Central venous dialysis catheters provide a readily available, easily placed, reliable vascular access. They can be used immediately once inserted, connection to the dialysis circuit is straight forward and needle free and catheters provide sufficient blood flow to allow adequate hemodialysis. They are, however, commonly associated with a number of complications including blockage and malfunction as a

result of either by intra- or peri-catheter thrombosis, malpositioning and/or migration, central venous stenosis or thrombosis, and catheter-related bacteremia and sepsis.<sup>1</sup>

The aim of this study is to identify the causes of immediate or early failure (within 7days) of long-term hemodialysis catheters and the accuracy of the current diagnostic modalities for assessment of such causes.

## Patients and methods:

This study was carried out on 51 patients who presented to the Vascular Clinic of

Nasser Institute for Research and Treatment from June 2011 to June 2012 with immediate or early failure (within 7 days) of long term hemodialysis catheters (Amecath®, Ameco Medical Industries, EGYPT).

Following thorough history taking and clinical examination, all patients underwent duplex scanning and magnetic resonance venography. Our focus in the examination was the central venous system where the catheters have been inserted. For purpose of analysis the veins examined were divided to the following segments: Internal jugular vein, subclavian vein, external iliac vein, and common femoral vein on both sides.

Duplex ultrasound studies were performed in the Radiology Department of Nasser Institute by a certified radiologist experienced in the procedure. The veins examined were evaluated by means of 5-mHz and 7-mHz linear array scanners (Aspen Advanced, Siemens Erlangen, Germany). Examination was performed in both longitudinal and transverse planes. Spectral waveforms were obtained at each examination level, and color Doppler interrogation was used throughout.

Magnetic resonance venography (MRV) was performed using a 3 T MRI machine (Siemens Magnetom Trio Tim System, Munich, Germany) using a phased-array body and neck coil. Scout images were obtained with a fast spoiled low angle shot (FLASH) gradient-echo sequence, 3D sequence in the coronal orientation to depict the jugular, subclavian, external iliac, and common femoral vein segments.

Statistical analysis: Analysis was done by use of SPSS program version 17. Data was reported as mean  $\pm$  the standard deviation of the mean. Results were compared using Chi-square test for comparing proportions and 2-tailed Student t test for comparing means. Results were considered significant at a *P* value less than 0.05.

The study was approved by the Ethics Review Board of the hospital, and written informed consent was obtained from all patients enrolled in the study.

## Results:

The age range for the study patients was 53-80 years with a mean age of  $64.59 \pm 6.74$ . Included were 24 males (47.1 %) and 27 females (52.9%), **Table (1)**.

The distribution of catheter insertion sites was as follows: Right subclavian vein 17 (33.4%), left subclavian vein 14 (27.5%), right internal jugular vein 8 (15.7%), the left internal jugular vein 6 (11.8%), right common femoral vein 4 (7.8%) and left common femoral vein 2 (4.8%), **Table (2)**.

All patients had previous temporary or long term dialysis catheters inserted. The number of previous catheters inserted for the study group is shown in **Table (3)**.

Duplex scan on the venous system showed 4 cases (7.8%) of deep venous thrombosis, 3 cases (5.9%) of attenuation of the deep veins while in the remaining 44 cases (86.3%) no abnormality could be detected in the deep veins and malfunction was considered secondary to catheter malposition.

On the other hand MRV showed occlusion of the deep veins in 4 cases (7.8%), attenuation of the deep veins in 13 cases (25.5%) and patent deep veins in the remaining 34 cases (66.7%), **Table (4)**.

Statistical analysis showed that sensitivity of duplex scan for detection of the occlusion of the central venous system in relation to MRV is 41% and the specificity is 100% while the negative predictive value is 77% and a positive predictive value of 100%, **Table (5)**.

There was no significant age difference between patients with occluded versus attenuated veins. All the patients with occluded central venous system were females (4/4, 100%). On the other hand females accounted for 61.5% of cases of central vein attenuation, **Table (6)**. The most affected vein segment by attenuation was the right subclavian vein (35.3%) followed by the left subclavian vein (29.4%), **Table (7)**.

Patients were managed by flushing and repositioning of the catheters in 34 cases (66.7%), and catheter removal was necessary in the remaining 17 patients (33.3%).

**Table (1): Age & gender distribution of the study group.**

Age (years) n=51		
Mean±SD	64.59 ± 6.74	
Median	64.0	
Range	53-80	
Gender	No	%
Male	24	47.1
female	27	52.9

**Table (2): Distribution of catheter insertion sites.**

Site of insertion	n = 51	
	No	%
Right subclavian vein	17	33.4
Left subclavian vein	14	27.5
Right internal jugular vein	8	15.7
Left internal jugular vein	6	11.8
Right common femoral vein	4	7.8
Left common femoral vein	2	4.5

**Table (3): Number & percent distribution of previous catheters.**

No. of previous catheters	n = 51	
	No	%
1	6	11.8
2	6	11.8
3	10	19.6
4	10	19.6
5	11	21.6
6	8	15.7

**Table (4): Number & percent distribution of duplex and MRV results.**

	Duplex n (%)	MRV n (%)
Occluded	4 (7.8)	4 (7.8)
Attenuated	3 (5.9)	13 (25.5)
Patent	44 (86.3)	34 (66.7)

**Discussion:**

Long term dual lumen catheters provide an alternative vascular access in dialysis patients considered unsuitable for arteriovenous fistula, graft or peritoneal dialysis. However, the use of such catheters is often complicated by inadequate blood flow.<sup>2,3</sup>

Several factors can account for such low blood flow. Formation of an intraluminal or

periluminal catheter clot is a common cause which can be treated or prevented by local flushing with heparinized saline, daily low-dose warfarin, local thrombolysis, or J-wire passage through the catheter. Occasionally the low blood flow is related to the catheter tip malposition or lying against the atrium or central vein wall. Such cases can be repositioned under fluoroscopic control

**Table (5): Comparison between duplex & MRV results.**

Occluded or attenuated		MRV results		Fisher's Exact test	p-value
Duplex results	occluded	7	0	16.2	<0.001
	Patent	10	34		
Sensitivity	Specificity	Positive predictive value		Negative predictive value	Accuracy
41%	100%	100%		77%	80%

**Table (6): Comparison between demographics for patients with occluded & attenuated central veins.**

	Occluded N = 4		Attenuated N = 13		Test of significance	p-value
Age					Mann Whitney U test 0.28	0.78
Mean±SD	65.0 ± 5.4		65.6 ± 5.8			
Median	65.5		65.0			
Range	59-70		57-75			
Gender	No	%	No	%	Fisher Exact test 2.18	0.26
Male	0	0	5	38.5		
Female	4	100	8	61.5		

**Table (7): Distribution of lesions in the venous system by MRV.**

Site	Attenuation	Occlusion
Right subclavian vein	6 (35.3%)	-
Left subclavian vein	5 (29.4%)	-
Right internal jugular vein	-	1 (5.9 %)
Left internal jugular vein	-	1 (5.9 %)
Right common femoral vein	-	1 (5.9 %)
Left common femoral vein	-	1 (5.9 %)
Right external iliac vein	2 (11.8 %)	-

or even by simply changing the patient's posture or by inversion of the arterial and venous lumen.<sup>4</sup> Stenosis or attenuation of the central veins commonly results from previous temporary or long term dialysis catheter and is another important cause for malfunction of subsequent catheter placement as demonstrated in the present study.

Menegazzo and colleagues reported on their preliminary experience concerning the value of magnetic resonance imaging in the assessment of the upper limb veins prior to creation of hemodialysis fistulas emphasizing

its importance in evaluation of the central veins particularly in patients with previous central vein cannulation. In this regard MRV provides a big advantage over duplex ultrasonography which is less accurate in evaluation of the intrathoracic veins.<sup>5,6</sup>

The utility of balanced steady-state free precession MR venography in the diagnosis of lower extremity deep venous thrombosis has shown a sensitivity of 94.7%, specificity of 100%, positive predictive value of 100%, and negative predictive value of 97.7% for the diagnosis of deep venous thrombosis.<sup>7</sup>

Tanju et al investigated the diagnostic value of direct contrast-enhanced three dimensional magnetic resonance venography in mapping the deep venous system of the upper extremities. The results of MR venography and conventional venography were consistent with each other (100% sensitivity and 100% specificity). The authors concluded that direct contrast-enhanced 3D MR venography is a well-tolerated sensitive technique for pre-surgical planning before placement of dialysis catheters or creation of arterio-venous fistulas. It is also helpful to investigate the cause of the malfunction of such procedures. It provides high-quality images quite comparable to conventional venography with the advantage of being non-invasive.<sup>2</sup> Similar results have been shown by other authors.<sup>8,9</sup>

Superiority of MRV over duplex in evaluation of the intra-thoracic central veins for venous thrombosis was demonstrated by several authors.<sup>6,10,11</sup>

In the present study, duplex scan was equivalent to MRV in detection of central venous thrombosis as a cause of malfunction of long-term dialysis catheters. However MRV was much more sensitive in detection of central vein attenuation or stenosis secondary to previous temporary or long-term catheter insertion.

### Conclusion:

The study has shown that several causes account for malfunction of long term hemodialysis catheters including malposition, intra or peri-catheter thrombosis, and central vein attenuation or stenosis secondary to previous dialysis catheter insertion.

Venous duplex scan was found equivalent to MRV in detection of central venous thrombosis as a cause of malfunction of long-term dialysis catheters. However MRV was much more sensitive in detection of central vein attenuation or stenosis. Based on these findings we recommend the wider use of MRV for investigating patients with early malfunction of such dialysis catheters. For patients with previous catheter insertion MRV evaluation is recommended before attempts

at new long term catheter insertion.

### Reference:

- 1- Fry AC, Stratton J, Farrington K, et al: Factors affecting long-term survival of tunneled hemodialysis catheters: A prospective audit of 812 tunneled catheters. *Nephrol Dial Transplant* 2008; 23: 275–281.
- 2- Tanju S, Sancak T, Düşünceli E, et al: Direct contrast-enhanced 3D MR venography evaluation of upper extremity deep venous system. *Diagn Interv Radiol* 2006; 12: 74–79.
- 3- Mandolfo S, Galli F, Costa S, Ravani P, Gaggia P, Imbasciati E: Factors influencing permanent catheter performance. *J Vasc Access* 2001; 2: 106–109.
- 4- Jean G, Chazot C, Vanel T, et al: Nephrology Dialysis Transplantation Brief Report. Central venous catheters for hemodialysis: Looking for optimal blood flow. *Nephrol Dial Transplant* 1997; 12: 1689–1691
- 5- Turmel-Rodrigues L, Bourquelot P, Raynaud A, Beyssen B, Sapoval M: Hemodialysis fistula: Preoperative MR venography: A promising but partial view. *Radiology* 2000; 214: 1–11.
- 6- Shinde TS, Lee VS, Rofsky NM, Krinsky GA, Weinreb JC: Three-dimensional Gadolinium-enhanced MR venographic evaluation of patency of central veins in the thorax: Initial experience. *Radiology* 1999; 213: 555–560.
- 7- Lindquist CM, Karlicki F, Lawrence P, Strzelczyk J, Pawlyshyn N, Kirkpatrick ID: Utility of balanced steady-state free precession MR venography in the diagnosis of lower extremity deep venous thrombosis. *Am J Roentgenol* 2010; 194: 1357–1364.
- 8- Thornton MJ, Ryan R, Varghese JC, Farrell MA, Lucey B, Lee MJ: A three-dimensional gadolinium-enhanced MR venography technique for imaging central veins. *Am J Roentgenol* 1999; 173: 999–1003.
- 9- Polak JF, Fox LA: MR assessment of the extremity veins. *Semin Ultrasound CT MR* 1999; 20: 36–46.
- 10- Laissy JP, Cinqualbre A, Loshkajian A, et al: Assessment of deep venous thrombosis in the lower limbs and pelvis: MR venography versus duplex Doppler sonography. *Am J Roentgenol* 1996; 167: 971–975.
- 11- Rose SC, Gomes AS, Yoon HC: MR angiography for mapping potential central venous access sites in patients with advanced venous occlusive disease. *Am J Roentgenol* 1996; 166: 1181–1187.