Complications of arteriovenous fistula in dialysis patients at Assiut University Hospital

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Background
Repeated access to the circulation is essential to perform adequate maintenance hemodialysis. Dysfunction of fistulas is the most common reason for secondary intervention and recurrent hospitalization.

Aim
The aim of this study was to report our experience regarding incidence, diagnosis, and different modalities of treatment of complications of arteriovenous fistula.

Patients and methods
This study was conducted prospectively on 239 end-stage renal disease patients who presented to the Department of Vascular Surgery of Assiut University Hospital with complicated arteriovenous (AV) accesses from January 2014 to January 2015. All patients underwent detailed history taking, and data were collected on age, sex, cardiovascular risk factors, history of previous accesses, and any complications that developed since the use of the access. Patients were further evaluated using clinical examination, duplex ultrasound, and fistulography if needed.

Results
There were 137 (42.7%) males and 102 (42.7%) females with a mean age of 57 ± 4 years. Hypertension was the risk factor in 103 (43.1%) patients, whereas diabetes mellitus was present in 45 patients. Of the 239 patients, 57 (23.8%) presented with infected AV access, 42 (17.6%) with thrombosed AV accesses, 33 (13.8%) with bleeding, and 31 (12.9%) with pseudoaneurysms. Venous hypertension was the presenting complication in 26 (10.9%) patients, whereas aneurysmal dilatation, hematoma, and ischemic steal were the presenting complications in 25 (10.5%), 20 (8.4%), and 5 (2.1%) patients, respectively.

Conclusion
Complications of hemodialysis access create significant problems for nephrologists and the healthcare system. Access interventions are often costly, challenging, and may require specialized surgical expertise. Management of complications associated with AV access is an integral part of planning individual hemoaccess procedures.

Keywords:
arteriovenous fistula, assiut, complications, dialysis

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Introduction

Hemodialysis (HD) was developed as a successful temporary treatment for patients with end-stage renal disease (ESRD) awaiting transplantation. Repeated access to the circulation is essential to perform adequate maintenance HD [1].

The small number of available kidney donors and the increased survival of patients mean that most will require a prolonged period of artificial renal support, necessitating the formation of arteriovenous fistulas (AVFs) [2].

The most frequent complications are thrombosis, aneurysm formation, vascular steal syndrome, venous hypertension, hemorrhage, infection, and neurological disorders.

Early detection and treatment of these complications prevent more severe conditions and consequently save additional costs and reduce hospitalization periods [2].

Aim

The aims of this study were to report our experience regarding incidence, diagnosis, and different modalities of treatment of complications of AVF and to study the impact of age, risk factors, and history of previous vascular access.

Patients and methods

This study was conducted prospectively on 239 ESRD patients who presented to the Department of Vascular Surgery of Assiut University Hospital with complicated arteriovenous (AV) accesses from January 2014 to January 2015.

All patients underwent detailed history taking, and data were collected on age, sex, and cardiovascular risk factors such as diabetes mellitus (DM) and hypertension. In addition, history of previous access and any complications that developed since the use of that access were ascertained.

Patients were further evaluated using clinical examinations, duplex ultrasound, and fistulography if needed.

Infected AVFs were diagnosed by the presence of manifestations such as erythema, cellulitis, discharge, exposed access, and/or sinus tract. Duplex ultrasound imaging was helpful in confirming the diagnosis by detecting abscess formation or perigraft fluid collections.

Pseudoaneurysm was diagnosed clinically by the presence of a mass closely related to the fistula with palpable thrill and audible murmur and confirmed by duplex examination. A pseudoaneurysm typically appeared as an echolucent sac that was pulsatile in B-mode, with a swirling flow pattern using color Doppler study, and a characteristic 'to-and-fro' flow pattern on spectral waveform analysis. Duplex also was helpful to differentiate between pseudoaneurysm and hematoma.

Thrombosed AVF was diagnosed clinically by the absence of palpable thrill or audible murmur. Duplex was used to identify site, extension of thrombosis, and whether the thrombus was fresh or old.

Venous hypertension was suspected clinically by the presence of diffuse limb edema and/or dilated veins on the chest wall. Diagnosis was confirmed by fistulography to evaluate the patency of central veins.

The clinical diagnosis of ischemic steal was suspected in presence of the cold extremities, flow augmentation with access compression, intermittent ischemia only during dialysis, claudication, ischemic pain at rest, and/or tissue loss. A variety of studies was used to confirm the clinical diagnosis of ischemic steal in HD patients, including physical examination with and without compression of the access, estimation of the ankle–brachial index, color duplex ultrasound, and even arteriography if arterial lesion was suspected.

Statistical analysis

Statistical analysis was performed using SPSS (17.0; SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were used, with continuous variables expressed as mean ± SD and categorical data expressed as percentages.

Results

This study was conducted prospectively on 239 ESRD patients with complicated AV accesses who presented to the Department of Vascular Surgery of Assiut University Hospital from January 2014 to January 2015.

There were 137 (42.7%) males and 102 (42.7%) females with a mean age of 57 ± 4 years (range: 40–65 years) (Table 1).

Hypertension was the risk factor in 103 (43.1%) patients, whereas DM was present in 45 (18.8%) patients. On the other hand, 41 (17.5%) patients had multiple risk factors, and 49 (20.5%) patients had no risk factor (Table 2).

Of the 239 patients, 57 (23.8%) presented with infected AV access, 42 (17.6%) with thrombosed AV access, 33 (13.8%) with bleeding, and 31 (12.9%) with pseudoaneurysms. Venous hypertension was the presenting complication in 26 (10.9%) patients, whereas aneurysmal dilatation, hematoma, and ischemic steal were the presenting complications in 25 (10.5%), 20 (8.4%), and five (2.1%) patients, respectively (Table 3).

Infection

Fifty-seven (23.8%) patients of our study group presented with severe infection in the form of either abscess formation or active bleeding. Therefore,

Table 1 Sex distribution of the study

Sex	Frequency (*n* (%))
Male	137 (57.3)
Female	102 (42.7)
Total	239 (100)

Table 2 Risk factors

Risk factors	Frequency (*n* (%))
HTN	103 (43.1)
DM	45 (18.8)
Cardiac disease	1 (0.4)
Multiple	41 (17.2)
No	49 (20.5)
Total	239 (100)

DM, diabetes mellitus; HTN, hypertension.

conservative treatment was not an option, and all of them underwent urgent access ligation.

Thrombosed access

Thirty (71.4%) patients with thrombosed autogenous AV access were encountered during the study period. None of them underwent a trial of thrombectomy as a result of either late presentation or thrombus propagation. New accesses were created in these cases.

On the other hand, 12 (28.6%) patients with thrombosed prosthetic AV access underwent surgical thrombectomy followed by completion fistulography. No further management was required in five (41.7%) cases, whereas balloon angioplasty was necessary in seven (58.3%) cases because of the presence of residual anastomotic stenotic lesions (Table 4).

Bleeding

Early postoperative bleeding was encountered in 10 (30.3%) patients, and managed by surgical exploration to deal with the source of bleeding and/or protamine sulfate administration in cases of heparin overdose.

Fourteen (42.4%) patients with bleeding AV accesses were treated by repair of the underlying puncture site either by simple suturing in 12 (85.7%) patients or by patch angioplasty in two (14.3%) patients. Nine (27.3%) patients were treated by ligation of the access due to infection (Table 5).

Pseudoaneurysm

It was the presenting complication in 31 (12.9%) patients. Of them, 29 (93.6%) patients were treated successfully by repairing the underlying site of puncture either by simple suturing in 20 (69%) patients, by patch angioplasty in six (20.7%) patients, or by using interposition prosthetic graft in the remaining three (10.3%) patients. Ligation of the access was the only possible modality of treatment in the remaining three (6.4%) patients because of anastomotic disruption (Table 6).

Venous hypertension

Of the 26 patients who presented with venous hypertension, six (23%) patients were successfully treated with ligation of the distal vein, and 13 (50%) patients underwent balloon angioplasty of the central veins (stenosis or occlusion) that was successful in restoring the patency of the venous outflow tract in seven (54%) cases.

On the other hand, seven (27%) patients underwent primary ligation of the access because of late presentation with massive edema, severe pain, and skin bullae (Table 7).

Aneurysmal dilatation

Twenty-five (10.5%) patients presented with either localized or diffuse aneurysmal dilatation over the venous outflow tract. Aneurysmorrhaphy was performed successfully in 22 patients with localized aneurysms, whereas ligation of the access was performed in three patients with diffuse aneurysmal venous outflow tract (Table 8).

Hematoma

Hematoma was the presenting complication in 20 (8.4%) patients. Seventeen (85%) patients were

Table 3 Complications of arteriovenous fistulas

Complications	Frequency (*n* (%))
Infection	57 (23.8)
Thrombosis	42 (17.6)
Bleeding	33 (13.8)
Pseudoaneurysm	31 (12.9)
Venous HTN	26 (10.9)
Aneurysmal dilatation	25 (10.5)
Hematoma	20 (8.4)
Steal	5 (2.1)
Total	239 (100.0)

HTN, hypertension.

Table 4 Management of thrombosed arteriovenous fistulas

Modality of treatment	Frequency (*n* (%))
Surgical thrombectomy	5 (41.7)
Surgical thrombectomy + balloon angioplasty	7 (58.3)
Total	12 (100)

Table 5 Management of bleeding arteriovenous fistulas

Modality of treatment	Frequency (*n* (%))
Surgical exploration/protamine sulfate	10 (30.3)
Repair of the access	14 (42.4)
Ligation of the access	9 (27.3)
Total	33 (100)

Table 6 Management of pseudoaneurysms

Modality of treatment	Frequency (*n* (%))
Repair of the access	29 (93.6)
Ligation of the access	3 (6.4)
Total	31 (100)

Table 7 Management of venous hypertension

Modality of treatment	Frequency (*n* (%))
Ligation of the distal vein	6 (23)
Balloon angioplasty	13 (50)
Ligation of the access	7 (27)
Total	26 (100)

successfully treated by hematoma evacuation and repair of the underlying site of puncture. The remaining three (15%) patients underwent ligation of the access because of late presentation with potentially infected hematomas (Table 9).

Ischemic steal

During the study period, only five (2.1%) patients presented with ischemic steal, and it was very severe in one (20%) case and mandated ligation of the access. Three (60%) patients underwent successful band ligation of the access, whereas the Distal Revascularisation with Interval Ligation (DRIL) procedure was successfully performed in the remaining case (20%) (Table 10).

Discussion

HD was developed in 1944 as a successful temporary treatment for patients with ESRD awaiting transplantation. Repeated access to the circulation is essential to perform adequate maintenance HD [1].

Complications of vascular access remain the Achilles heel for many patients with ESRD. Therefore, early detection and treatment of complications prevent more severe conditions and consequently save additional costs and reduce hospitalization periods.

Our study group had male (57.3%) predominance, with a mean age of 57 ± 4 years (range: 40–65 years). Others studies have also reported similar findings [3,4].

Hypertension was the risk factor in 103 (43.1%) patients, whereas DM was present in 45 (18.8%) patients. On the other hand, 41 (17.5%) patients had multiple risk factors, and 49 (20.5%) patients had no risk factors.

Table 8 Management of true aneurysms

Modality of treatment	Frequency (*n* (%))
Aneurysmorrhaphy	22 (88)
Ligation of the access	3 (12)
Total	25 (100)

Table 9 Management of hematoma

Modality of treatment	Frequency (*n* (%))
Hematoma evacuation	17 (85)
Ligation of the access	3 (15)
Total	20 (100)

Table 10 Management of steal phenomena

Modality of treatment	Frequency (*n* (%))
Band ligation	3 (60)
DRIL procedure	1 (20)
Ligation of the access	1 (20)
Total	5 (100)

In contrast, Salahi *et al.* [4] reported on 184 complicated AVFs, and in their series diabetes was the risk factor in 58 (31.5%) cases and hypertension was the risk factor in 50 (27.1%) cases.

Of the 239 patients, 57 (23.8%) presented with infected AV accesses, 42 (17.6%) with thrombosed AV accesses, 33 (13.8%) with bleeding, and 31 (12.9%) with pseudoaneurysms. Venous hypertension was the presenting complication in 26 (10.9%) patients, whereas aneurysmal dilatation, hematoma, and ischemic steal were the presenting complications in 25 (10.5%), 20 (8.4%), and five (2.1%) patients, respectively.

In contrast, in the study by Salahi *et al.* [4], 184 patients presented with complicated AVFs, one case presented with infected AVF, four cases presented with thrombosis, and one case presented with bleeding. Eighty-six (46.7%) cases presented with aneurysm formation, and venous hypertension was present in 25 (13.5%) patients. Steal syndrome was the clinical presentation in 26 (14.1%) patients.

In this study, 57 (23.8%) patients presented with infected AVFs. The infection was serious enough to warrant excision and abandonment of all these AVFs.

In contrast, Raju [5] reported infection in 110 (35%) patients in his series of 312 patients with polytetrafluoroethylene (PTFE) grafts. Ninety (82%) grafts required surgical intervention to control infection. A local bypass around the area of infection was performed in 44 (49%) grafts. Thirty (33%) grafts underwent excision and abandonment. Simple incision, drainage, and systemic antibiotics were the mode of treatment for nine (10%) grafts. Localized infection was excised, and the graft was covered over by fresh tissue in seven (8%) cases.

In addition, Schwab *et al.* [6], reported 17 cases of infected prosthetic AV accesses that were managed with partial graft excision and segmental bypass and achieved an early success rate of 94%. However, they noted episodes of recurrent infection in portions of the remaining grafts during follow-up.

Thrombosed autogenous AV access was encountered in 30 patients during our study period. None of them underwent a trial of thrombectomy. Rather, reconstruction of new accesses was performed in these cases.

In contrast, Palmer *et al.* (2006) reported their experience about surgical thrombectomy followed by fistulography in 10 patients with thrombosed autogenous accesses. Although restoration of patency was successful in seven (70%), the primary patency rate at 6 months was only 51%.

In our series, 12 (28.6%) patients who presented with thrombosed prosthetic AV accesses underwent surgical thrombectomy followed by completion fistulography. Of them, seven (58.3%) patients required balloon angioplasty to maintain patency.

On the other hand, Ko *et al.* [7] reported 13 patients with thrombosed prosthetic grafts. Surgical thrombectomy plus balloon angioplasty were performed successfully to restore access blood flow in all patients. The primary patency rates of the dialysis grafts following these hybrid procedures at 1, 3, and 6 months were 77% (10/13), 62% (8/13), and 38% (5/13), respectively.

In our study, pseudoaneurysm was the presenting complication in 31 (12.9%) patients. Twenty-nine (93.6%) patients were treated by repair of the underlying site of puncture either by simple suturing in 20 (69%) patients, by patch angioplasty in six (20.7%) patients, or by interposition prosthetic graft in the remaining three (10.3%) patients. The remaining three (6.4%) patients underwent ligation of the access.

Georgiadis *et al.* [8] reported surgical revision of 44 HD access patients who presented with complicated aneurysms. The mean postintervention primary patencies were 93, 82, 57, and 32% at 3, 6, 12, and 24 months, respectively.

Aneurysmal dilatation over the venous outflow tract was the presenting complication in 25 (10.5%) patients. Aneurysmorrhaphy was performed in 22 patients with localized aneurysms, whereas ligation of the access was performed in three patients with diffuse aneurysmal venous outflow tract.

Similarly, Pasklinsky *et al.* [9] reported 23 patients with true aneurysms. Thirteen (56%) patients were treated by ligation of the fistula. However, 10 (44%) patients underwent aneurysmorrhaphy.

Among our study group, 26 patients presented with venous hypertension. Six (23%) patients underwent ligation of the distal vein. Abandonment of the access was performed in seven (27%) patients. Thirteen (50%) patients underwent balloon angioplasty of the central veins with a clinical success rate of 54%.

Ozyer *et al.* [10] reported the results of 147 accesses with venous hypertension managed with 101 angioplasties and 46 stent placements. Although the primary patency rate was significantly higher in the angioplasty group than that in the stent group, the assisted primary patency of the angioplasty group and that of the stent group was equivalent.

Moreover, Shi *et al.* [11] described the management of 24 HD accesses with central vein stenosis or obstruction with either balloon angioplasty alone or with stent placement. They concluded that there was no significant difference in patency rates between the two groups.

Only five patients of our study group presented with ischemic steal. Ligation of the access was performed in one (20%) case. Three (60%) patients underwent band ligation of the access, whereas the DRIL procedure was performed in the remaining (20%) case.

Mwipatayi *et al.* [12] described the management of 18 patients with ischemic steal. Intervention was through the DRIL procedure in 12 (66.7%) patients with satisfactory outcome, ligation in five (27.8%), and banding in one (5.5%).

Conclusion

Complications of HD access create significant problems for nephrologists and the healthcare system. Access interventions are often costly, challenging, and may require specialized surgical expertise. Management of such complications associated with AV access is an integral part of planning individual hemoaccess procedures.

Functional AVF is a major determinant of successful HD; however, AVFs may be a risk factor for hospitalization in dialysis patients. Knowledge about the potential complications of AVFs should contribute to their timely detection and allow measures to prevent deleterious consequences that range from loss of vascular access to serious morbidity, which may ultimately be fatal. Therefore, AVF care should be a priority not only for patients but also for the entire professional team involved in the treatment of dialysis patients.

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Conflicts of interest

There are no conflicts of interest.

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