Venous bypass as a surgical solution for central venous occlusions in upper-limb venous hypertension of hemodialysis patients with native arteriovenous fistula (short-term results)

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Purpose
To elaborate the safety of venous bypass as a surgical solution for venous hypertension due to central venous occlusion for hemodialysis patients with native arteriovenous fistula (AVF).
Patients and methods
The single-center retrospective cohort study included 17 hemodialysis patients with native AVF presenting with upper-limb venous hypertension due to central venous occlusion who underwent venous bypass.
Results
The improvement in the form of circumference reduction of the wrist, mid-forearm, elbow, and mid-arm was 93.4, 94, 88, and 92%, respectively, in the first 6 months postoperative. The patency rate was 88.2 and 82% over 6 and 12 months, respectively.
Conclusion
Venous bypass can be used as a surgical solution for central venous occlusions in upper-limb venous hypertension of hemodialysis patients with native AVF in cases of failed endovascular management.

Keywords:
central venous occlusion, venous bypass, venous hypertension, hemodialysis

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Introduction

Chronic kidney disease is considered as a major chronic illness worldwide, which was estimated to be nowadays as 850 million people [1]. There are 3.4 million people living on dialysis worldwide [2]. The estimated number of patients on hemodialysis in Egypt nowadays is 105 000, however, this number is expected to increase on time [3]. The hemodialysis through native arteriovenous fistula (AVF) was considered the main way of management [4]. Maintaining the native fistula for dialysis is the main goal for the patient and the treating physician [5]. Every effort should be executed to prolong the use of the native AVF [6]. One of the major problems that endangers the fistula is the central vein occlusion [6]. Endovascular intervention or venous surgical bypass was the treatment subjected for this type of lesions [7].

Patients and methods

This is a retrospective analysis of prospectively collected registry data case–controlled study of 17 patients who were presented to the Vascular Surgery Unit of Kasr Alainy Surgical Department, Cairo University. Patients are end-stage renal disease patients on hemodialysis presented with unilateral upper-limb venous hypertension with long-standing functioning native AVF.

Inclusion criteria that should be available in an upper limb of all patients:

(1) Unilateral upper-limb venous hypertension.
(2) Native AVF.
(3) Central venous occlusion.

Failed endovascular management of central venous occlusion.

Exclusion criteria:

(1) Bilateral upper-limb venous hypertension.
(2) Previous venous bypass.

All patients were thoroughly examined after proper history taking, including the type, site, duration, and side of the AVF, and history of previous central venous

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catheter insertion (side and site). When did the patient develop venous hypertension (onset, course, and duration)?

Patients' clinical examination included recording the extent of edema in the upper limb, the chest, the face, and the circumference of the diseased and the control limb (other nondiseased side) at the wrist, mid-forearm, elbow, and mid-arm.

Duplex examination was done with details about the functioning of the AVF, the level of occlusion of the central vein, also examination of the ipsilateral jugular vein patency, contralateral subclavian, and internal jugular vein (IJV) patency. If there was superior vena cava syndrome or there was contralateral central vein occlusion, it resulted in venous duplex of the ipsilateral lower limb. Usually, venography is done preoperatively as diagnostic tool to assess the level of occlusion or as a first step during endovascular management.

Statistical analysis

The recorded study data were compiled and recorded in Microsoft Excel 2010 program and later exported to the data editor page of statistical software, SPSS version 20.0 (IBM Corp., Armonk, New York, USA). Frequency distribution was calculated for qualitative data. Kaplan–Meier survival analysis was conducted for the determination of patency rate.

Ethical consideration

Approval of the study from the local ethics committee was obtained. All patients or their relatives were informed about the study and written consent was obtained from each patient.

Preoperative

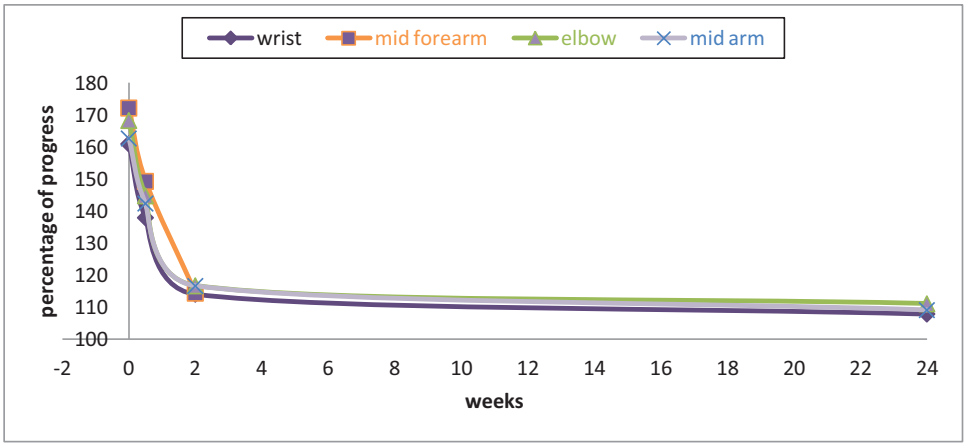
The patient was prepared by routine preoperative labs, ECG, echocardiography, chest radiograph, duplex examination to detect the rate of flow, and preoperative hemodialysis on the day preceding the operation and to be scheduled for hemodialysis on the day following the procedure. General anesthesia was done in all patients. Eight-mm-diameter ringed polytetrafluorethylene (PTFE) graft was used as a conduit from the proximal dilated arterialized vein (cephalic or axillary vein) to the nearest patent central vein in the upper half of the body (ipsilateral, jugular, contralateral jugular vein, contralateral axillary vein, or the ipsilateral femoral vein) in cases of bilateral upper-limb venous occlusion by a subcutaneous tunnel, anastomosis was done by polypropylene double-armed needle 5/0 rounded body (Table 1). Vessel-sealing devices like harmonic scalpel or ligature were used to dissect over the arterialized vein as venous hypertension made it difficult to dissect in the arm of venous hypertension (Fig. 1).

Table 1 Type of veno-venous bypass

Type of bypass	Number	Conduit
Cephalic–contralateral jugular vein	10	8-mm PTFE-ringed graft
Cephalic–contralateral jugular vein	1	Saphenous vein
Axillo-contralateral jugular vein	4	8-mm PTFE-ringed graft
Axillo-femoral	1	8-mm PTFE-ringed graft
Axillo-axillary	1	8-mm PTFE-ringed graft

PTFE, polytetrafluorethylene.

Figure 1



Left cephalo-jugular venous bypass (left cephalic vein in the delto-pectoral groove anastomosed to ringed PTFE graft that was tunneled subcutaneously to be anastomosed to the right internal jugular vein). PTFE, polytetrafluorethylene.

Postoperative

The wrist, mid-forearm, elbow, arm circumferences, and the extent of the edema are recorded at the same operative day and the following day and after 1 week, 1, 3, 6, 9, and 12 months. After 1 week, conventional angiography was done for documentation (Fig. 2a, b). Duplex examination were done postoperative to detect the rate of flow over the graft and compare this with flow over the fistula, during follow-up. Pain was recorded preoperative and postoperative to assess the pain reduction postoperative.

Comparison was done of the records of the AVF limb and the control (other non-AVF limb), recording the percentage of circumference-diameter reduction.

Results

There were 17 cases presented to Kasr Alainy Vascular Surgery Outpatient Clinic referred from hemodialysis unit, presented with unilateral venous hypertension after long-standing functioning surgically created AVF.

Demographic data

The age group ranged from 9 to 67-year old, the mean age group was 46.9 years. There were eight (47%) males and nine (53%) females.

Only five patients were hypertensive, two had ischemic heart disease, one was diabetic, and none of the patients in this series was a smoker.

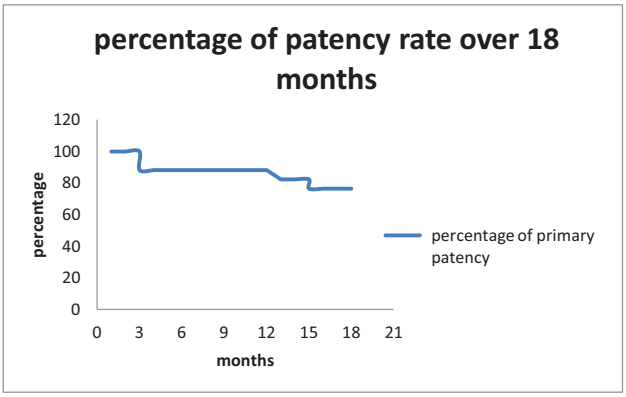
Patients' criteria

The fistula side was nine over the left side and eight over the right side. There were nine brachiocephalic AVF, six brachiobasilic with superficialization, and two radiocephalic AVF. Regarding the age of the fistula, there was only one patient with functioning fistula less than 2 years, nine patients had fistula that was aged 2–5 years, while six patients were aged more than 5 years. All patients had trials of endovascular management 12 (failure to cross the lesion), three (with angioplasty of the central vein), and two (failed angioplasty and stent). We used an 8-mm ringed PTFE graft JOTEC as a conduit in most of the patients, except one patient where we used saphenous interposition graft. The preoperative duplex flow assessment was ranging from 750 to 4200 ml/min. The postoperative duplex flow rate over the graft was recorded and compared with the flow preoperative, it reaches 75–100% drainage of the flow of the fistula.

All patients experienced major pain reduction postoperative from 5–7 to 0–2 according to universal pain assessment tool. Regarding the movements of the upper limb (shoulder, elbow, and wrist joints), most patients experienced marked improvement in movement of all joints in the upper limb on the first postoperative day (16 patients). Only one patient (the saphenous graft conduit) showed improvement of the upper-limb function of the fifth day postoperative.

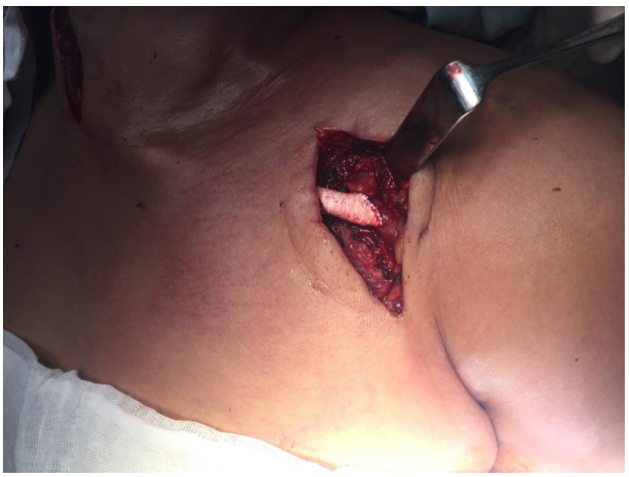
The reduction of upper-limb edema was represented by marked reduction of the circumference of the arm, elbow, and wrist, in comparison with the preoperative measurements, and continues to reduce in the follow-up period to become stationary (no further circumference reduction). The improvement in the form of circumference reduction of the wrist, mid-forearm, elbow, and mid-arm was 93.4, 94, 88, and 92%, respectively in the first 6 months postoperative (Fig. 3).

Figure 2



(a) Venogram of the left upper-limb venous bypass showing the anastomosis of the left cephalic vein (a with ringed PTFE graft). PTFE, polytetrafluorethylene.

Figure 3

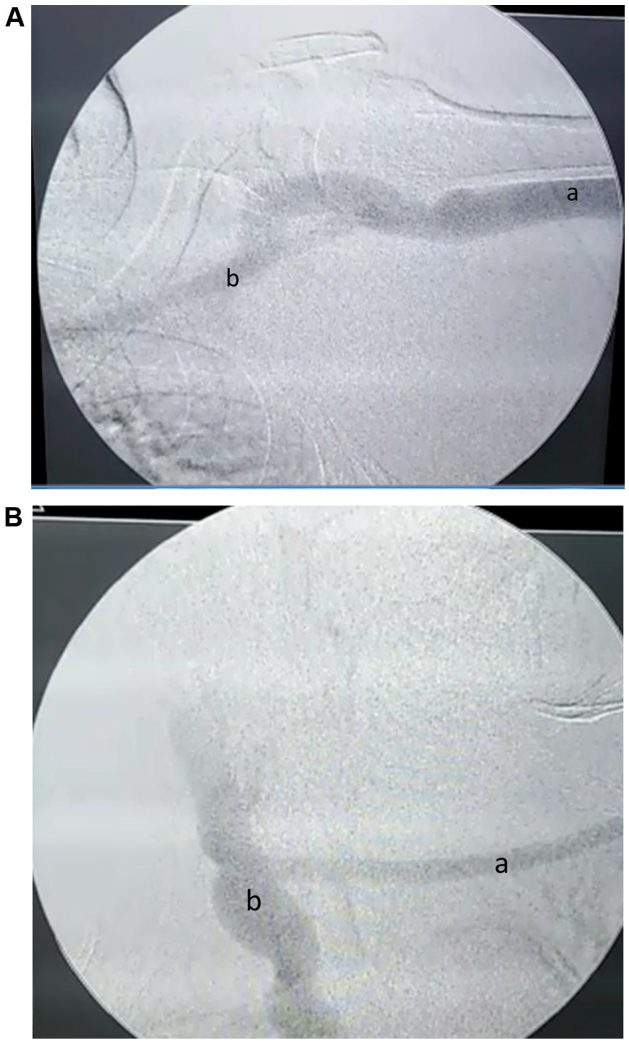


Percentage of circumference reduction over 6 months.

Regarding the functioning of the AVF, the fistulae were used for hemodialysis on the following day postoperative, with less edema, good thrill, and easy cannulation, in comparison with the preoperative situation.

Regarding the patency of the grafts in the follow-up period, there were no significant differences between the second week postoperative duplex and the first 6 months, but there was 9.7% increase of the flow rate in the patient with reversed saphenous vein graft. During the follow-up period, we noticed stable course in all cases in the proximal anastomosis, except one case with synthetic graft that had 20% stenosis after 6 months. We also noticed 40–75% stenosis in the distal anastomosis in eight (47%) cases in the first 6 months of the follow-up. The patency rates were 88.2 and 82% over 6 and 12 months, respectively (Fig. 4).

Figure 4



Patency rate over 18 months.

Regarding the morbidity in this series, we did not need any blood transfusion; however, 2 U of packed red blood cells were cross-matched and reserved for each case. Only one case of surgical-site infection was noticed in the cephalic–jugular bypass by saphenous that was treated by antibiotics and repeated dressing. Regarding the mortality, we had only one case of mortality after 2 months of the postoperative period.

Discussion

Access for a patient with AVF is considered as if it is their lives, especially those who had been on dialysis for a long time. Occlusion of the central vein with failure of the endovascular management of such cases raises the use of surgical solution in the form of venous bypass for such cases. The available solutions of such surgery were the ipsilateral venous bypass to the IJV, contralateral IJV, or the ipsilateral femoral vein. Most of the patients involved in this series had fistula age more than 9 years (n=9), some had 5–9 years (n=6). Trying to salvage the fistula and continuing to use it the fistula is considered as a goal by the patient and the treating physician. All patients had trial of failed endovascular management. We had been able to use the fistula immediately on the first postoperative day, without the need of inserting a temporary catheter that was well-appreciated by the patient.

The dramatic improvement of most of the patients within the first two postoperative weeks where the patient could use his/her limb, the edema 80–90% subsided in the first two postoperative weeks, promoted us to advice the patients to this type of surgery.

The drainage flow of the fistula was 75–100%. The duplex clearly proved the proper flow drainage of the fistula that can be presented clinically by pain reduction, functional improvement of the limb, and circumference reduction.

The patients' symptoms (pain, difficulty of movement of the limb, and edema) were all improving as a result of marked reduction of the limb circumference that is well-proved by duplex measures that confirmed that the drainage of the fistula was 75–100%. We used the other nondiseased upper limb as a reference (control) for the target reduction concerning the circumference that showed the course of circumference reduction postoperatively. On the review of literature, we could not find the use of the circumference of the upper limb as a method of measurement (objective) to assess the course of reduction postoperatively. The

improvement of the upper-limb function was observed on the following day postoperatively in almost all patients, except the one where we used the saphenous vein as a conduit, the improvement was delayed the fifth postoperative day. This discrepancy was probably related to the smaller caliber of the saphenous in comparison with the 8-mm PTFE graft. This also could be confirmed by the discrepancy of flow drainage by duplex between the synthetic graft PTFE and the saphenous vein. We have found that saphenous vein conduit was the least decompressive procedure as regards the degree and rate of edema resolution, which may be explained by the resistance of the saphenous vein to maturation.

The ringed PTFE was advised to be used as it is externally supported, does not necessitate harvesting time unlike the saphenous vein that is collapsible, and not externally supported. Some authors advised spiral vein graft to increase the caliber of the vein, but we thought it is more lengthy in time to harvest and do spiral vein graft [8].

Surgical-site infection was noted in one case with cephalic–jugular bypass using the saphenous vein because this case had even a contraindication of the use of synthetic graft and that was why we used the saphenous (got infection that was resolved by repeated dressing).

The National Kidney Foundation (NKF) Disease Outcomes Initiative (KDOQI) guidelines in 2006 recommended percutaneous transluminal angioplasty (PTA), with or without stent placement, as the preferred intervention for central vein lesions (CVL) [9]. The management of these lesions as usually initiated by endovascular intervention that required angioplasty of the stenotic lesion. Recurrence was frequent as mentioned by Krishna *et al*. [10] in their series due to the elastic nature of central vein disease and required repeated PTAs. As a consequence, the 1-year primary patency after PTA of CVL is only 20%. Deployment of stents does not improve these outcomes. Another study done by Bakken *et al*. [11] comprising 73 patients, demonstrated a technical success rate of PTA (46 patients) alone 76% with primary patency rates of 58, 45, and 29% at 3, 6, and 12 months, respectively and PTA with stent (26 patients) with primary patency 21% after 12 months. There were cumulative patency rates of 76, 62, and 53% at 3, 6, and 12 months, respectively. That study showed neither PTA alone nor PTA with stent, which offered durable longevity for the AVF.

Another study was done on 97 patients by the Belgian Society of Radiology on the patency of bare metal stent placement as a treatment for central venous occlusion. Technical success was achieved in almost half of the 49 (50.5%) patients. The primary patency rates of central veins were 34.4% (17 patients) and 15.8% (eight patients) at 6 and 12 months, respectively. The assisted primary patency rates were 77.3% (38 patients) and 61% (30%) at 6 and 12 months, respectively [12].

Another promising way of endovascular management of CVL was to deploy a covered stent. A study done by Anaya-Ayala *et al*. [9] on 25 patients with CVL showed 29, 85, and 94% of primary patency, assisted primary patency, and secondary patency, respectively, over 12 months. Dealing with occlusions of one of our cases was found occluded (the case of axillo-femoral bypass) after 2 years, and we tried surgical patch angioplasty for the distal anastomosis with graft thrombectomy, and in this case, the graft remained patent for a whole one-and-a-half year.

As we can notice from the previously mentioned data, patency of angioplasty with or without stenting is still not that effective as most of the patients fail to complete 6 months postoperatively without the need for secondary intervention or assisted trials to maintain patency of the stent. Needless to mention the expensive cost of the devices used starting from the multiple wires, various balloon diameters, stents, the quality of life, and the effect of delayed-dialysis sessions with a compromised access remains a problem that suggests another modality of treatment.

However in cases of failure of the endovascular option, the surgical option rose in mind, including ligation of the fistula (not amenable to use any more), direct surgical correction. for example, venous patch (carried high morbidity and hazardous), vein transposition, and veno-venous bypass that was adopted in the current series. The veno-venous bypass included cephalic–IJV bypass (ipsilateral or contralateral), axillo-axillary bypass, ipsilateral axillo-femoral, or saphenous vein bypass. In the current series, the same-side IJV was advocated as a recipient for the veno-venous bypass lest the same-side innominate vein is patent, otherwise, the contralateral IJV, or subclavian vein, was used as a recipient outflow. The conduit was usually the ringed PTFE 8-mm graft that gives better drainage of the fistula with risk of more surgical-site infection. In this series, the graft drainage was immediate as measured by the upper-limb

circumference reduction, while the saphenous vein as a conduit was delayed to postoperative day 5. Some authors did the spiral vein graft to have more and less drainage.

Another case series done by many authors showed primary patency of 80% over 1 year [13,14]. Another series used the cephalic axillary–femoral bypass with patency rates of 100% and 87.5% over 6 and 12 months, respectively [15].

Conclusion

Venous bypass can be used as a surgical solution for central venous occlusions in upper-limb venous hypertension of hemodialysis patients with native AVF in cases of failed endovascular management. There is a significant improvement of pain, edema, and upper limb (circumference and functional movement), especially within 2 weeks after venous bypass for upper-limb hypertension. There was 75–100% drainage of outflow detected by duplex postoperatively. The patency rates were 88.2 and 82% over 6 and 12 months, respectively. We recommend it superiorly to standard treatment of endovascular management as per cases with long occlusions of central veins.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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