Surgical management of aneurismal dilation of vein and pseudoaneurysm complicating hemodialysis arteriovenous fistula

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Received: September 2007 / Accepted: November 2007

Abstract

Background Pseudoaneurysm (PS) and aneurismal dilation of vein (ADV) are recognized complications of arteriovenous fistulas (AVF) in patients on hemodialysis. We present our experience about surgical management of these complications, which resulted in AVF preservation for continuing hemodialysis.

Material and methods Twenty-two patients underwent surgical repair of an aneurismal dilation of vein or a pseudoaneurysm arising from a native AVF. In 14 patients the aneurismal dilation of vein arose from the venous limb of AVF and in eight patients the pseudoaneurysm arose from an arteriovenous anastomotic site in the antecubital and anterior part of arm. The mean follow-up period was 15 months. Clamp Aneurysm Repair (CAR) was performed to repair the aneurismal dilation of venous limb of AVF and Tourniquet Aneurysm Repair (TAR) was performed to repair PS that arose from AVF in the antecubital and anterior part of arm.

Results In eight of the 14 patients with aneurismal dilation of vein, who underwent CAR procedure, vascular access was preserved. In three patients with aneurismal dilation of vein in snuffbox and one in forearm, the AVF had failed due to prior venous thrombosis of AVF. In two of 14 patients, there was no need for preservation of AVF because of renal transplantation. The technical success rate and patency rate during follow up period in CAR method was 100%. In seven of eight patients with pseudoaneurysm in the antecubital and anterior part of arm, who underwent TAR procedure, the AVF remained patent. The technical success rate in TAR method was 87.5%, and the patency rate was 87.5%. Overall, technical success rate was 95.45% and patency rate was 93.75%. During the 15 months of follow up period hemodialysis program through the repaired AVF sustained as desired.

Conclusions The surgical methods used in our study could effectively repair the aneurismal dilation of vein and pseudoaneurysm arising from a native AVF, and it lead to preservation of the AVF patency for continuing hemodialysis. These methods are technically feasible, safe and cost-effective procedures. It does not require dissection and additional incision for control of the vein and artery proximal and distal to the aneurismal dilation of vein and pseudoaneurysm; result in shorter time of procedure without complications.

Keywords Aneurysm · Dilation · Pseudoaneurysm · Arteriovenous fistula · Hemodialysis

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Introduction

Hemodialysis access fistulas were developed as a long-term therapeutic device in the management of severe renal insufficiency. Vascular access patency for dialysis is the

main problem in patients who undergo long-term hemodialysis [1]. Native arteriovenous fistula (AVF) are generally considered preferable in comparison with other vascular access, because they are less often associated with complications such as infection, pseudoaneurysm (PS), venous hypertension, and vascular steal than prosthetic grafts [2], also they have a better patency rate compared to prosthetic grafts [3].

Complications related to AVFs have been encountered much more often in recent years because of the expanding population of this patient group. PS is the first major result of anastomotic line leakage following AVF creation, and aneurismal dilation of vein (ADV) is a recognized complication of AVFs, which mostly results from fistula usage. Vessel rupture and bleeding, thromboembolism, AVF thrombosis and failure, local skin ischemia and necrosis, infection and sepsis, extrinsic compression of nearby neurovascular structures, and significant blood loss have all been associated with ADV or PS. Considering to limited sites for AVF creation in hemodialysis patients, a series of multiple revision procedures were done to salvage and maintain access sites.

Treatment modalities for ADV and PS developing as a complication of AVF include: surgical ligation, ultrasound(US)-guided compression, placement of a covered stent, embolization, ultrasound(US)-guided percutaneous thrombin injection, and surgical reconstruction [4–7], but the traditional surgical approach still maintains its place as the best treatment modality [8].

Although the role of surgery has diminished since the development of less-invasive methods of treatment for ADV and PS, there are still other recognized indications for surgical repair such as: any PS at the site of a vascular anastomosis, mycotic PS, rapidly expanding PS; infected PS; failure of percutaneous treatment; and ischemic soft tissues and skin caused by local pressure [9–11].

In the past decade, the management of ADV and PS has changed completely. The main treatments have been ultrasound (US)-guided compression and US-guided percutaneous thrombin injection. US-guided compression has respectable success rates but is limited due to patient discomfort, long procedural times, and the relative ineffectiveness of the technique in anticoagulated patients [12–15]. In addition, there are just some case reports on the use of this method resulting in preservation of AVF patency [6]. US-guided percutaneous thrombin injection is effective in patients, who have undergone anticoagulation and seems to be the best method to treat PS, with very high technical success rates, minimal recurrence, and very low complication rates [6, 16–19]. But, thrombin injections should only be performed in patients who develop PS secondary to a catheterization procedure. Additionally, the AVF could not be preserved with the use of this method.

However, with the increasing number of elderly patients, and patients with co-morbid conditions such as

cardiovascular disease and diabetes mellitus in the hemodialysis population, with limited sites for AVF creation, it is important to use a procedure for management of ADV and PS, which maintain the AVF patency.

We present our experience of surgical management of ADV and PS that have developed as a complication of AVF, which result in AVF preservation for continuing hemodialysis.

Patients and methods

Patients

During the period from February 2004 through June 2006, 22 patients were treated at the department of surgery, Shariati hospital affiliated to Tehran University of Medical Science, with an ADV or a PS arising from a native AVF. The patients included eight women and 14 men with a mean age of 40.7 years (range 17–67 years).

All 22 patients had the native AVF for hemodialysis; seven located in the snuffbox (between cephalic vein and dorsal branch of radial artery), four in the distal of forearm, radio-cephalic (between cephalic vein and radial artery), and 11 in the antecubital region, brachio-cephalic or brachio-basilic (between basilic or cephalic vein and brachial artery).

ADV arose from the venous limb of AVF in 14 patients that were in the snuffbox (n=7), distal of forearm (n=4), and antecubital and anterior part of arm (n=3). PS arose from an arteriovenous anastomotic site in the antecubital and anterior part of arm in eight patients (Table 1).

The mean period between AVF creation and ADV or PS development was 15.2 months (range 3–28 months) [20, 21], in our study, the diagnosis of ADV and PS was made based on clinical examination. Other than size of the PS or ADV as an indication for repair, more important were the pulsatile mass overlying the AVF, and high risk for acute rupture or thrombosis.

The mean follow-up period was 15 months (range 9–18 months). Follow-up included physical examination regarding the ability of continuing hemodialysis through the repaired AVF. Palpable trill on the venous limb of AVF indicated preservation of access patency and AVF function. Although Color Doppler ultrasonography was performed post-operatively in four patients, showed no complications, AVF was clinically functional due to continuing hemodialysis, and there was no need for ultrasonography to confirm AVF function and patency in the other patients. The ethics committee approved the study, and written consent was obtained from all patients after they were duly informed of the nature of surgical procedure.

Surgery

Clamp Aneurysm Repair (CAR) was performed to repair the aneurismal dilation of vein that arose from AVF in the snuff-box, forearm, and antecubital and anterior part of arm (Figs. 1, 2); following injection of local anesthetic (lidocaine 1%), the overlying skin and subcutaneous tissue was incised. Partial dissection was performed to expose aneurismal part and proximal and distal part of venous limb of AVF. A partially occluding vascular clamp was placed over ADV and acceptable part of the vein below the clamp was preserved, which resulted in re-establishment of the vein continuity. Then the part of vein below the clamp was sutured continuously with 5-0 prolene thread, and part of aneurysm above the clamp was resected. A second row of continuous suture was placed after removing the clamp. If the AVF had no function or thrombosed before surgical repair, the proximal and distal segment of the vein was ligated by the placement of a 2-0 silk suture.

Tourniquet Aneurysm Repair (TAR) was performed to repair the PS, which arose from AVF in the antecubital

Fig. 1 (A) The aneurismal dilation of vein before resection in a patient with a radiocephalic arteriovenous fistula in the distal of forearm (CAR method). (B) After vascular clamp placement for resection

Fig. 2 (A) The Aneurismal Dilation of Vein before resection in a patient with an arteriovenous fistula in the antecubital region (CAR method). (B) After vascular clamp placement for resection

and anterior part of the arm (Fig. 3); before surgery we explained to the patients about the presence of probable pain and paresthesia due to tourniquet inflation and they accepted the procedure to avoid general anesthesia and to have AVF preservation. The tourniquet was placed around the upper arm and after local anesthesia with lidocaine 1%, the upper limb elevation and distal to proximal milking of the upper limb was done, tourniquet was inflated to a pressure of 250–300 mmhg. After incising and separating the skin and subcutaneous tissue over the bulge site, the capsular wall of PS was opened using a direct incision. The organized thrombosis material was removed and the PS sac was resected, and the defect in the anastomotic site or part of the wall of the AVF that connected the artery and vein was repaired using a 6-0 or 5-0 prolene thread. Following the tourniquet deflation, venous and arterial continuity was preserved, AVF was functional, and the radial or radial plus ulnar pulses were palpable. After the placement of suction drain into the PS cavity – when establishment of homeostasis was achieved – the skin was closed. The maximum time of tourniquet inflation was 10–15 minutes. There was no

Fig. 3 (A) The Pseudoaneurysm before repair of the defect in a patient with an Arterio-Venous Fistula in the antecubital region (TAR method). (B) After resection of Pseudoaneurysm and repair

need for a general anesthesia because of the short time of tourniquet inflation, which resulted in tolerable pain.

Results

Twenty-two patients underwent resection and repair of an ADV or a PS complicating a native AVF during the two years study period. Of these, 14 were male and eight were female. The mean age was 40.7 (range: 17–67 years).

For all 14 patients with ADV in snuff box, forearm, and antecubital and anterior part of arm the CAR method was done to repair it, and for all eight patients with PS in antecubital and anterior part of arm the TAR method was done to repair it.

All eight patients with PS had a growing pulsatile mass overlying the AVF, and all 14 patients with ADV had increasing diameter of vein similar to aneurysm.

Palpable trill existed on the venous limb of the AVF after surgical repair. The radial and ulnar pulses were intact prior to the surgery and remained normal in the early post-opera-

tive period and also during follow up period.

No complication occurred during or after the surgical repair procedures.

In eight of 14 patients with ADV, in snuffbox (n=4), distal of forearm (n=1), and antecubital (n=3) region, who underwent CAR procedure, vascular access was preserved (Table 1). With regard to other six patients in this group, in three patients with ADV in snuffbox and one in distal of forearm, the AVF failed due to prior venous thrombosis of AVF and we ligated the vein proximal and distal to AVF. Temporary hemodialysis catheter was placed in the jugular vein in these patients until another AVF was created in the other extremity. In two of 14 patients, there was no need for preservation of AVF because they had successful renal transplantation previously.

The technical success rate for CAR method was 100%. Considering to preservation of eight AVF during the CAR procedure (primary patency), and remaining the patency during the follow up period, the patency rate was 100%.

In seven of eight patients with PS in the antecubital and anterior part of arm, who underwent TAR procedure, the AVF has remained patent and no additional interventions

Table 1 Demographic characteristics and outcomes of surgical repair of PS and ADV complicating native Arteriovenous fistula.

Age, y (range)	40.7 (16–67)
Sex, n (%)	
Female	8 (36.4%)
Male	14 (63.6%)
Origin of ADV, (%)	
Snuff box	7 (31.8%)
Distal of forearm	4 (18.2%)
Antecubital and anterior part of arm	3 (13.6%)
Origin of PS, n (%)	
Antecubital	8 (36.4%)
Procedures, n (%)	
CAR	14 (63.6%)
TAR	8 (36.4%)
Technical success rate (%)	
TAR	87.5%
CAR	100%
Whole	95.45%
AVF preservation, n (%)	
TAR	7 (87.5%)
CAR*	8 (100%)
Whole	93.75%

AD – aneurismal dilation; PS – pseudoaneurysm;

AVF – arteriovenous fistula

*The AVF was primarily preserved in eight of 14 patients with ADV and in all eight patients the AVF remained patent during follow up period

have been performed (Table 1). In one of eight patients, the AVF failed two weeks after surgery because of post surgical thrombosis. The technical success rate in TAR method was 87.5%, and the patency rate was 87.5%.

Overall, technical success rate was 95.45% and patency rate of AVF was 93.75%.

The preserved accesses were fully functional after 1–2 weeks post-operative, and the patients continued hemodialysis with a temporary hemodialysis catheter in the internal jugular vein during these 1–2 weeks.

There was no need for hospital stay except in one patient for one day. During the 15 months follow up period no aneurysm or PS, hematoma, or other abnormality in the region of previous treatment was identified and hemodialysis program through the repaired AVF was continued without vascular complications.

Discussion

The present study was based on 22 patients, who underwent surgical repair of aneurismal dilation of vein (ADV) or pseudoaneurysm (PS) arising from a native AVF, by clamp aneurysm repair (CAR) and tourniquet aneurysm repair (TAR) methods respectively. In 15 of 16 patients (93.75%) we got primary success as the AVF was functional, also the secondary patency rate was 93.75%, and the AVF remained patent and was fully functional during 15 months follow up. The technical success rate was 95.45% without future recurrence of ADV or PS, or complications at the site of previous treatment. The use of these surgical methods avoids the need for general anesthesia and hospitalization.

The creation of an AVF is widely performed to achieve easier access and to increase the quality of life for patients with chronic renal failure, who need hemodialysis. The most common complication of AVF, now seen is the development of an aneurismal dilation of venous limb of AVF. Patients on hemodialysis are also at high risk for developing pseudoaneurysm due to repeated cannulation of their surgically created AVF and concomitant heparinization [6].

Symptoms and signs of ADV and PS are pain, swelling, and a pulsatile mass. In our study, patients complained of a pulsatile mass, with or without pain and swelling. In all cases, the diagnosis was based on the history and physical examination.

Color Doppler ultrasonography is the most useful method to confirm diagnosis of ADV and PS, and if the diagnosis is clear on physical examination and/or ultrasonography, there is no need for another technique or investigation [22]. In some previous studies, the diagnosis of PS was made based on clinical examination [20, 21]. Also, during the follow up period of our patients, presence of palpable thrill was experienced on the venous limb of AVF on physical examination with an ability of continuing hemodialysis through the repaired AVF. However, we did not require ultrasonography to confirm the AVF function and its patency.

When an aneurysm related to AVF develops, it may be partially resected and the fistula preserved, or the fistula can be closed and a new one created. However, with limited sites for AVF creation in hemodialysis population, it is important to use a procedure, which maintains the AVF patency.

The modalities of management of ADV and PS complicating AVF include surgical repair, US-guided compression, placement of a covered stent, transcatheter coil embolization and US-guided percutaneous thrombin injection [4–7, 12–15, 16–19]. The use of US-guided compression and US-guided percutaneous thrombin injection is common, but surgery has important role in the management of these patients. The first purpose of treatment methods is repairing the ADV and PS with minimal recurrence rate, and the AVF patency preservation in some methods has been considered as the second aim [6, 7] (Table 2).

Experience with the use of stent-grafts for the treatment of PS has been extensively reported in numerous locations in the arterial system. There are limited reports on the use of this technique for the treatment of PS complicating AVF [23]. In a study by Najibi S. et al [7] about the use of covered stent for exclusion of arteriovenous graft and PS complicating AVF in the forearm and arm region in ten patients, the primary technical success rate was 90%, and the access maintained patent. However, several studies have recommended that the stent graft should not be cannulated for 2–4 weeks or left untouched [24, 25]. In our study the repaired AVF can be used for needle cannulation within 1–2 weeks after surgical repair and access patency continued within 15 months during follow up period.

In recent years, US-guided compression has emerged as the initial treatment for post-angiographic femoral artery PS [26, 27]. This procedure has also been used successfully

Table 2 Comparison of treatment modalities for pseudoaneurysm complicating AVF in patients on hemodialysis.

First Author (Ref. No.)	Year	number	location of AVF	method	success (%)	AVF preservation
Najibi (7)	2002	10	forearm and arm	covered stent	90%	yes
Karabay (5)	2004	18	antecubital	surgery	100%	no
Witz (6)	2000	3	forearm	UGC	100%	yes
Clark (4)	2000	2	arm	UPTI	100%	no

AVF, arteriovenous fistula; UGC, ultrasound-guided compression; UPTI, ultrasound-guided percutaneous thrombin injection.

to treat axillary and brachial artery PS. Most authors have reported technical success rates between 63% and 88% [12, 13, 15]. Witz et al [6] reported three hemodialysis forearm PS complicating AVF that treated by using this method with preservation of access patency. US-guided compression failure has been related to the size of the aneurysm (>4cm) and the presence of anticoagulation, although these issues are debatable [26]. The main drawbacks of the procedure are the demands of time placed on the sonologist and US machine and patient discomfort. In Coley's series [12], the mean compression time for all cases was 44 minutes (range, 10–300 min). In our experience with the use of TAR method, maximum time of tourniquet inflation was 10 min, which resulted in tolerable pain for patients and there was no need for general anesthesia and the patency rate was 87.5%.

US-guided percutaneous thrombin injection has been demonstrated to be a safe and effective treatment for iatrogenic PS of the femoral artery [14, 16, 19]. It is also effective for PS in sites other than the groin [15, 17, 18]. Clark and Abraham [4] successfully treated two patients with brachial artery PSs at the site of hemodialysis fistulas without complication. Sheiman et al [28] have also reported successful treatment of brachial artery PSs. With complete thrombosis of the PS used as an indicator of technical success, the results from most series are very good, with overall thrombosis rates of 93%–100% [6, 16–19]. Most reported complications of thrombin injection involve the escape of thrombin into the native circulation, causing distal embolization. However, the AVF patency is not persevered with this method. But, in our surgical methods, the technical success rate was 95.45% (one thrombosis after two weeks in TAR method), with no vascular complications during 15 months follow-up and the AVF patency was preserved in 93.75% of patients.

Despite the common use of endovascular techniques or interventions guided by US in the past decade, surgery is still required for some patients with infected and rapidly expanding PSs. The surgical technique depends on whether the PS is infected. The standard technique for surgical repair of noninfected PS needs blunt dissection to expose the underlying vessels and proximal and distal control of the vessels especially arterial component [10]. Karaby et al. [5] performed surgical management in 18 patients with giant aneurysms that developed on antecubital AVFs and reported technical success in all patients. Their surgical method included resection of aneurysm and re-establishment of arterial continuity; however because of resection of accompanying vein the AVF failed and its patency did not re-established. In our study both surgical methods avoided additional incision and extensive dissection in order to gain control of the artery and vein proximal and distal to the ADV or PS, which also lead to shorter time of procedure. In addition, we could preserve AVF for continuing hemodialysis.

Our surgery was performed under local anesthesia, which avoids the need for a general anesthesia in a group of patients, who generally have significant co-morbidities and do not tolerate general anesthesia and suffer significant blood loss due to major surgical procedure and extensive dissection.

In summary, the surgical methods used in our study effectively repaired the ADV or PS complicating native AVF, and preserved the AVF patency for continuing hemodialysis. These methods are technically feasible, safe, and cost-effective, which do not require additional incision and dissection to take control of the vein and artery proximal and distal to the ADV or PS. This also resulted in shorter time of procedure, without visible complications.

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