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PERCUTANEOUS TREATMENT OF THROMBOSED HEMODIALYSIS ARTERIOVENOUS FISTULAS: USE OF THROMBOASPIRATION AND BALLOON ANGIOPLASTY

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Abstract

Background. *Endovascular strategies have been used to manage patients with thrombosed vascular access for hemodialysis. We analyzed primary success rate and patency rates of balloon angioplasty following mechanical thrombectomy for the treatment of thrombosed native arteriovenous fistulas.*

Methods. *This was a retrospective study of 24 patients with thrombosed native arteriovenous fistulas who were referred for treatment in the intervention unit of the Radiology Department. All patients had been performed percutaneous thrombo-aspiration and balloon angioplasty. Technical and clinical success rates as well as the 6th and 12th months primary and secondary patency of fistulas were evaluated .*

Results. *Technical and clinical success was 83%. In the 6 of 20 patients, early re-thrombosis were detected. Patent AVF with primary and secondary patency rates at 6 and 12 months was 55%-40%. The secondary patency rates at 6 and 12 months were 75% and 70%.*

Conclusion. *Mechanical thrombectomy with balloon angioplasty is a minimally invasive and effective procedure for the treatment of thrombosed native arteriovenous fistula. Advantages of this technique are minor complication rates, cost effectiveness, high techni¬cal success rate.*

Keywords: arteriovenous fistulas, thrombus, thromboaspiration, balloon angioplasty

Introduction

Vascular access failure is a crucial problem in chronic hemodialysis patients. Native arteriovenous fistulas (AVFs) and polytetrafluoroethylene (PTFE) grafts are used commonly for hemodialysis access. Autogenous AVFs are considered the vascular access of choice as defined by the National Kidney Foundation's Dialysis Outcomes Quality Initiative guidelines [1]. Thrombosis is often caused either by associated vascular stenosis, which usually develops on the venous side of the shunt, or by venous thrombosis that occurs elsewhere in the same extremity, decreasing flow and increasing pressure [2]. In the past, dysfunctional fistulas were preserved by surgical methods. Today, the vast majority of dysfunctional fistulas including stenosis and thrombosis of hemodialysis fistulas are treated by interventional approach [1]. Currently, percutaneous treatment regimens of thrombosed fistulas are mechanical thrombectomy, pharmaco-mechanical thrombolysis and infusion thrombolysis. Percutaneous recanalization of hemodialysis accesses have been described as a valuable alternative to surgical thrombectomy, either with the use of various thrombolytic drugs alone or in combination with dedicated percutaneous catheter-based devices [3,4]. The advantage of the interventional approach is a less invasive method and that it does not consume the patient's venous reserve [5].

In this report, the technical and clinical outcomes of percutaneous thrombo-aspiration and balloon angioplasty in thrombosed autogenous dialysis fistulas and complications during and immediately after the procedure, as well as primary and secondary patency rates of the autogenous fistula were assessed.

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Methods

Patient population

This is a retrospective, single–center study based on collected data of dialysis accesses of patients with thrombus. Data was collected from Interventional Radiology Service database between January 1, 2013 and January 1, 2015. In this period, all patients, who had refered to Interventional Radiology Department because of totally occluded access without thrill as seen by physical examination, and a thrombus confirmed by ultrasonographic examination, were included in this study. All patients had been performed percutaneous thrombo-aspiration and balloon angioplasty. The exclusion criteria for endovascular treatment were an infected AVF, the presence of chronic wall-adherent thrombi, and those unable to provide an informed consent. Compatible patients for angioplasty were given the information about the potential benefits and risks of intervention technique and their written informed consents were obtained.

Devices

In all cases, we performed ultrasound examinations (Aplio 500, Toshiba, Tokyo, Japan) to investigate the AVF. All percutaneous thrombectomy procedures were performed by an interventional radiologist in our operating room equipped with a C-arm brillance (Siemens antis zee). 6 F guiding catheter (Cordis, FL, USA) for aspirations and 4-9 mm balloon catheters (Cook, Bloominton, IN, USA) were used for angioplasty.

Procedure technique

Non thrombose drainage vein segment was used as entry site for diagnostic and interventional procedures. Under ultrasonography guidance, drainage vein was punctured with 21 G intravenous cannula. Diagnostic angiography was obtained with injecting contrast media through intravenous cannula and compressing arterial flow on upper arm to see both arterial and venous side of AVF. A hydrophilic-coated, steerable, 0.035-inch Terumo guidewire (Terumo Corp., Tokyo, Japan) was advanced into the vessel through intravenous cannula. A 5-7 F intraducer sheath was inserted over the wire. A hydrophilic guide wire was tried to pass the thrombosed segment. Thrombo-aspiration was performed by intraducer sheath and angiographic catheter. Meanwhile, 3000-5000 U heparin was injected through intraducer sheath. After passing the thrombosed segment, various sized (4-9 mm) balloons were sealed. When adequate lumen was obtained, the procedure was completed. All interventions were performed as an outpatient procedure. If the fistula was working correctly on next dialysis session, the patients were called for control 1, 6 and 12 months later.

Definitions

According to the standard practice guidelines published by the Society of Interventional Radiology [6], technical success was defined as restoration of flow combined with less than 30% residual luminal diameter stenosis. Clinical success was defined as resumption of normal dialysis for at least one session. Primary patency rate was defined as the percentage of patent fistulas after intervention until the next access thrombosis or re-intervention. Secondary patency is defined as the time interval between initial intervention and vein thrombosis with failure of any endovascular technique, necessitating the creation of a new fistula, dialysis graft or catheter insertion.

All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statistical analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) 17.0 statistical software for Windows (SPSS Inc, Chicago, IL, USA). Kaplan Meier life table analysis was used for calculate patency of balloons. The information on patients and fistulas were retrospectively reviewed. The data are presented as mean standard deviation or the percentage. The outcomes including clinical success rates were determined by frequency.

Results

A cohort of 24 patients with thrombosed native AVFs was assessed. There were 21 males and 3 females. The mean age of the patients was 45.3±22.4 years (range, 20 to 70 years). The average time of fistula function after creation was 32±5.5 months (range 12 to 48 months). The mean length of thrombosed segment was 3±2.6 cm (range 1 to 6.2 cm). Eight of 24 patients AVFs were brachycephalic and remaining AVFs were radiocephalic. The average age of the thrombus was 36±3.5 hours (range,12 to 96 hours). The demographic characteristics of the patinets are presented in Table I. The thrombus was detected on drainage vein in all the patients. Technical failure occurred in 4 thrombosed AVFs due to the impossibility of traversing a guide-wire through the thrombotic segment of the vein and stenotic AV anastomosis. In those 4 thrombosed AVFs, open revisions were performed. Technical and clinical success was 83% (20/24). Thrombo-aspiration and balloon angioplasty were possible to be performed in 20 patients. In 6 of 20 patients, early re-thrombosis were detected after 10 days. These patients were not able to undergo successful dialysis session through fistula after the procedure; 14 of 20 AVFs were patent on first month (70%).

Complications occurred in 2 of the 24 procedures and all of these were puncture site hematomas. There wase no procedure related early major complication. None of the patients had clinical respiratory distress during or imme¬diately after the procedure that would represent pulmonary embolism. One patient died due to cardiac conditions two month after angioplasty. In 6 months, patent

AVF with primary patency was 55% (11/20) and in 12 months, patent AVF with primary patency was 40% (8/20) (Figure 1). The secondary patency rate at 12 months was 70% (Figure 2). Eight patients who had re-thrombosis after thrombo-aspiration and balloon angioplasty underwent re-intervention. But in 2 patients whose dialysis AVF circuit was occluded, percutaneus transluminal angioplasty was unsuccessful. We therefore inserted a tunneled cuffed catheter via the internal jugular vein until the time of the reoperation.

Table I. Demographic Characteristics.

Charecteristics	Value
Number of patients	24
Male/female	21/3
Patient age (y±std)	45.3±22.4
Dialysis access age (mo±SD)	32±5.5
Type of AV fistula	
Radiocephalic	16
Brachycephalic	8
Mean length of thrombosed segment	3±2.6 cm

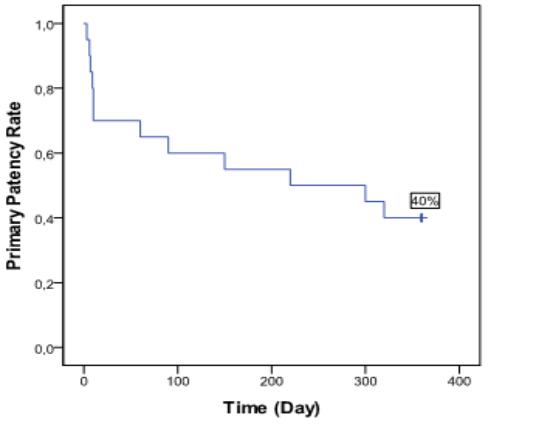

Figure 1. Kaplan-Meier curve for primary patency rates after restoration of dialysis fistula.

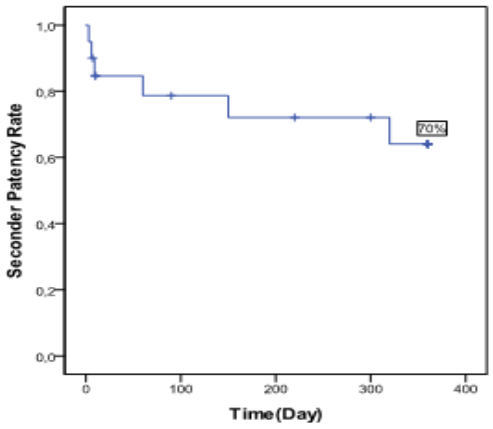

Figure 2. Kaplan-Meier curve for secondary patency rates after restoration of dialysis fistula.

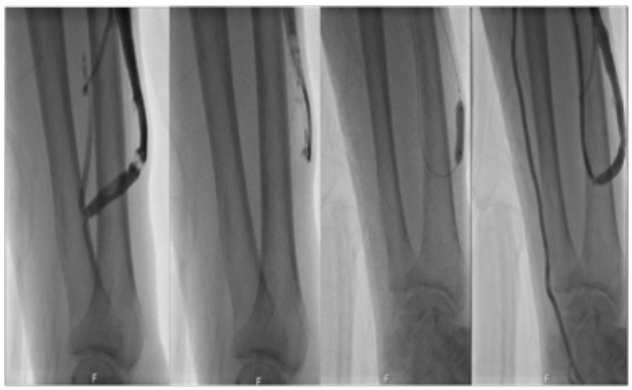

Figure 3. A 70 year–old man presented with an acutely occluded radiocephalic fistula vein.

Contrast injection reveals clear clot burden over the distal part of the efferent vein. After retrograde aspiration of thrombus with catheter and additional balloon angioplasty, no residual of clot and stenosis was identified.

Discussion

Thrombosis of arteriovenous fistula (AVF) and arteriovenous graft (AVG) should be treated as soon as possible without unnecessary delay and within 48 hours, prior to the next dialysis session. Early declotting allows for immediate use of the access without the need for a central venous catheter [7]. Predisposing factors are an underlying stenosis or aneurysmatic vein causing flow turbulences as well as arterial hypotension, decreased arterial inflow and clotting disorders [8]. In the vast majority of cases venous stenosis is the cause of thrombosis. Therefore, applied percutanous balloon angioplasty for stenosis can prevent early thrombosis in most of the cases. Both surgical and percutaneous approach may be performed to manage thrombotic hemodialysis fistula. Dapunt et al. [9] compared the results of 37 transluminal angioplasties with those of 37 operations in the treatment of stenoses and occlusions of dialysis fistulae. Cumulative patency after 12 months was 31.3% for angioplasty and 19.3% for surgery. Surgical thrombectomy with revision has a poor outcome with reported success rates ranging from 28% to 73% [10,11]. Percutaneous endovascular treatment of the thrombosed native fistula is another option. Favorite methods are mechanical thrombectomy and pharmacomechanical thrombolysis [12]. The advantage of mechanical thrombectomy is shorter time of the opera¬tion. However, the disadvantage of this method includes expensive thrombectomy devices and potential damage to the venous wall. Thrombolysis is the procedure that uses a thrombolytic agent to lyse the thrombus. The disadvantage of this method is hemorrhage. The primary patency rates have been reported in changing range from 20% to 51% for 12 months after these procedures [13,14]. Yang et al. [15] used mechanical thrombectomy with

hydrodynamic mechanism and rotational mechanism in 275 procedures and they reported postintervention primary patency rates at 1, 6, and 12 months at 70, 45, and 30% in the hydrodynamic device used group and 76, 43, and 29% in the rotational device used group, respectively. In a recent study by using percutaneous rheolytic thrombectomy device reported primary and secondary patency rates at 12 months were 56.1% and 86.2%, respectively (16). In our study, the primary patencies at 6 and 12 months were 55% and 40%. And secondary patency rate 12 months was 70%.

Lack of image guidance is one of the important difficulties of surgery for detection and treatment of additional stenosis during the operation. Stenoses were identified in more than 90% of cases at the time of percutaneous thrombectomy or thrombolysis [17,18]. Thereforepercutaneous balloon angioplasty has become an attractive alternative in the treatment of AVF thrombosis.

We prefer thrombo-aspiration and balloon angioplasty in thrombotic AV fistula. We were able to provide enough flow in all AVF, which was passed with guide wire. But we experienced early re-thrombosis in 6 (30%) patients. These patients AVF's had various degrees of thromboses on the vessel wall, which could be the cause of re-thrombosis. Therefore, it is important to provide as much as possible declotting for long term patency. If re-thrombosis occurs, re-intervention can be done in a similar way with primary angioplasty. Manual catheter-directed thrombo-aspiration was technically successful in 20/24 patients, with prompt restoration of a thrill and bruit. This study showed 83% technical and clinical suc¬cess rates. Usually, a technical failure is due to the impossibility of traversing a guide wire through the occluded segment because of longer and thrombotic segment or a significantly anastomotic stenosis as in our study and in previous studies [15,16,19]. Fresh and short thrombotic segments were easily passed and aspirated. Therefore, the intervention should be done as soon as possible to obtain high success rate. Complications had occurred in 2 of the 24 procedures and all of these were puncture site hematomas in our study. Clinically significant pulmonary embolism is a rare and major compli¬cation of the percutaneous treatment of thrombosed AVFs which the incidence ranges from 0% to 1% [20]. There was no clinically significant pulmonary emboli in our study.

There were limitations of this study such as: it was a retrospective study with a small number of enrolled patients and there was no comparison between different techniques.

In conclusion, thrombo-aspiration and percutaneous balloon angioplasty can be used as first line procedure in native hemodialysis AVF include underlying stenosis with short and fresh thrombosis. Advantages of this technique are shorter time of the operation, minor complication rates, cost effectiveness, high techni¬cal success rate. Moreover, percutaneous angioplasty can be repeated as an outpatient procedure if re-thrombosis develops.

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