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Research Article

Haemostasis with suture-tourniquet technique following removal of large-bore venous sheaths for endovascular recanalization of acute thrombosis in native arteriovenous fistula

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Abstract

Purpose: To investigate the suture-tourniquet technique for haemostasis in patients with acute thrombosis of native arteriovenous fistula (AVF) whom underwent manual aspiration thrombectomy using large-bore venous sheaths and high dose heparin.

Methods: Between January 2016 and May 2018, patients with acute AVF thrombosis performed successful manual aspiration thrombectomy by using large bore venous sheaths and high dose heparin were included in this retrospective study. Success rate for haemostasis, procedural complications clinical and imaging follow up was reported descriptively.

Results: A total of 52 patients with 64 procedures met the inclusion criteria. In 60(94%) of 64 procedures, successful haemostasis was achieved with suture-tourniquet technique. In 2(3.1%) of the 64 procedures, the suture broke while turning the tourniquet and haematoma occurred in another 3 procedures (4.7%) although suture-tourniquet technique was applied appropriately. Manual compression was performed in these patients. There were 3 major complications unrelated the suture-tourniquet technique.

Conclusion: The suture tourniquet technique can achieve haemostasis rapidly and can be safely used with low complication rates without fistulae thrombosis after large-bore venous sheath removal following treatment of AVF thrombosis.

More Information

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Keywords: Arteriovenous fistula; Manual aspiration thrombectomy; Haemostasis; Purse-string suture; Suture-tourniquet; Large bore venous sheath

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Introduction

Autologous arteriovenous fistula (AVF) is accepted as the most effective and durable route for haemodialysis. However, complications such as stenosis and occlusion can be quite frequent [1]. In the treatment of stenotic or occlusive AVF complications, endovascular recanalization has an important role due to its minimally invasive nature and effective results [2].

Most of AVF interventions require large-bore venous sheaths and concomitant heparinization especially in cases of acute thrombosis. One of the most important technique used in the treatment of acute thrombosis is the manual aspiration thrombectomy through a large-bore venous sheath along with high dose heparinization. Therefore, haemorrhagic complications such as bleeding and haematoma can be seen more frequently after the sheath removal [1,3,4]. These local complications can occur frequently in daily practice but are currently underreported in the literature [5].

Manual compression is the most commonly used technique for haemostasis. However, it takes at least 15 minutes to achieve haemostasis, and this time can be prolonged due to use of large-bore venous sheaths and heparin dose can further prolong achievement of haemostasis [1,6]. Additionally, since the digital pressure at a certain and consistent degree is hard to maintain for a long time, inappropriate pressure can also lead to rethrombosis or haemorrhage [1,3,6]. Various procedures for achieving haemostasis were described in the literature previously [1,3,4,6]. A primitive suture-based technique was initially used by Uflacker, et al. as a single skin suture under digital compression [7]. Vorwerk, et al. described the classic

purse string suture, which defines circular suture placement around the puncture site, in haemostasis of haemodialysis fistula and graft interventions [4]. Simons et al.[6] described Woggle method which was a modified purse string suture technique and used a tension collar and a suture lock device to achieve haemostasis without making a knot. However, these techniques are not without disadvantages such as the difficulty of adjusting the optimal tension on the suture and removing the sutures which is buried in the subcutaneous tissue or infection around the retained suture if it is removed late for the purse string suture method [8,9] and Woggle method needs a simple but additional equipment such as a suture lock device and also it needs a considerable learning curve period. Suture-tourniquet technique, a variant of purse-string suture, was initially described by Zaleski, et al. [3]. Unlike purse-string suture, it uses a plastic tourniquet derived from the dilator of the venous sheath, which adjusts the optimal tension and does not result a buried suture. Zaleski, et al. described this technique in a study which included patients most of whom had arteriovenous graft (AVG) with relatively small-bore venous sheaths. Different from Zaleski's initial method, nowadays native AVF are mostly used for haemodialysis rather than AVG and some AVF interventions need large-bore (≥ 8 Fr) venous sheaths and high-dose heparin. In this study, we aimed to test the use of the suture-tourniquet technique to achieve haemostasis in patients with acute thrombosis of AVF whom underwent manual aspiration thrombectomy using large-bore venous sheaths.

Materials and Methods

Study design and patient population

This study was approved by the local ethics committee and informed consent was waived due to retrospective nature of the study. Our institutional electronic database and clinical patient follow-up charts were searched between January 2016 and May 2018 retrospectively for haemodialysis AVF recanalization treatment procedures. Patient demographics, number of sheaths, sheath sizes, follow up period and complications were noted. Inclusion criteria were as follows: presence of native acute AVF thrombosis, having a successful manual aspiration thrombectomy procedure and suture-tourniquet closure technique.

AVF thrombectomy and the suture-tourniquet closure procedures

Supraclavicular brachial plexus blockage were applied in all patients and additional intravenous analgesia and sedation were also administered when needed. Venous punctures were made under ultrasonography guidance by using a micro puncture set. Large-bore venous sheaths, including 8 or 9 French size, were used for manual aspiration thrombectomy. All patients received 5000 IU heparin IV shortly after placement of the vascular sheath. During the procedure, a maintenance dose of 1,000 IU heparin/h was given via the IV route. First, an upper extremity diagnostic venogram was obtained by administration of a non-ionic contrast agent via venous sheath. The 8 Fr or 9 Fr guiding catheter, depending on the venous sheath size, was inserted through the sheath and moved to-and-fro within the 1-2 cm length of the thrombotic segment while negative aspiration was manually provided using a 20-ml syringe. Aspiration procedure was continued until free blood flow was obtained within the syringe and the catheter was removed under negative pressure. Control venogram and colour Doppler ultrasonography (CDUS) was performed after the aspiration procedures. If a stenotic segment was present, balloon angioplasty was applied additionally.

Purse string suture, which is the first step of the suture-tourniquet technique, was applied to the entry site by using 2.0 polypropylene material. As previously described by Zaleski, et al. [3]; we cut the plastic dilator of the sheath into 3 to 5 cm segments, placed it between the suture material and skin, and rotated the plastic dilator clockwise to tighten the suture over the puncture site. Rotation of the dilator was stopped as soon as haemostasis was achieved. Then the plastic dilator which was used as a tourniquet was taped down parallel to the efferent vein. The duration of application of the miniature tourniquet technique took 1-2 minutes. The sutures were removed one-hour after the procedure if there was no bleeding or leak while loosening the tourniquet.

If complete fistula and venous patency was achieved, the patient was allowed to have haemodialysis through AVF subsequently. However, if the AVF had an insufficient flow rate or high venous mural thrombus burden or chronic stenosis with a poor response to balloon angioplasty, a temporary central venous catheter was placed to the patient for haemodialysis.

Post-procedural follow-up

All patients were evaluated with color Doppler US and underwent clinical examinations for any complications and fistula patency before discharge and within 1 week and 3 months after the procedure.

All patients were discharged on the same day and prescribed low-molecular weight heparin (enoxaparin sodium 0.4 ml, 40 mg, once daily subcutaneously, Clexane®, Sanofi Aventis Pharma) for one week. 15 patients had already received acetylsalicylic acid for peripheral vascular disease and 2 patients with atrial fibrillation had also received oral anticoagulant agents to prevent thromboembolic agents. These anticoagulation medications were not withheld before or after the procedure.

Results

A total of 52 patients (n = 17 women, n = 35 men, mean age 47 years, range 22-76 years) met the inclusion criteria. 39

fistulas were located in the left and 13 were in the right upper extremity. There were 4 snuff-box, 29 wrist, 4 upper-arm and 15 elbow AVFs. A total of 64 large-bore venous sheaths were used in 50 retrograde and 14 anterograde accesses. 37 of 64 venous sheaths were 8F and 27 of 64 were 9F. 5 of 64 procedure were performed for recurrent acute thrombosis after the first thrombectomy procedure in the follow up period (mean time after the first procedure was 6.25 months, range 2-13). In 4 patients with concomitant chronic stenosis, a retrograde 5 Fr venous sheath was additionally placed after a failed retrograde attempt. Suture-tourniquet technique was performed in all patients. Mean heparin dose was 6300 IU (range 5000-8000 IU).

After the procedures, 20 patients underwent immediate subsequent haemodialysis and 19 patients underwent haemodialysis session 1 day after the procedure. In 13 patients, a central venous catheter was inserted and 8 of them had haemodialysis after the first week CDUS evaluation. 5 of them had insufficient flow rate because of restenosis and/or mural thrombi based on CDUS so venography and balloon angioplasty were performed via 5 or 6 Fr venous sheath. All these 5 patients had haemodialysis 2 weeks after the first procedure.

Successful haemostasis was achieved in 60 (94%) of 64 procedures. Technical-failure related to suture-tourniquet was observed in 4 (6.2%) of 64 procedures. In 1(1.6%) of the 64 procedures, the suture broke while turning the tourniquet and haemostasis was achieved by manual compression. Haematoma occurred in 3 procedures (4.7%) although suture-tourniquet technique was applied appropriately. Manual compression was performed in these patients and sutures were left in place and removed after 1 hour in these patients and hematomas didn't progress during the follow up period. In 1 patient, the suture got loose during postoperative follow-up period and leakage was seen but the leak was stopped by turning the tourniquet to clockwise. Sutures were removed one hour after the procedure all except 8patients. These 8 patients' sutures were removed one day after the procedure.

There were major complications in 4 of 52 patients (7.7%) unrelated to suture-tourniquet technique. One of this was a pseudoaneurysm which was seen in cranial segment of the left cephalic vein, distant from the puncture location, in the first week follow-up and this occurred most likely secondary to "to and fro" movement of the guiding catheter. This pseudoaneurysm was occluded by percutaneous thrombin injection into the cavity while an intravenous inflated balloon support was used to cover the neck of the pseudoaneurysm. The other two complications were rupture of efferent veins after balloon angioplasty and one of them treated with a stent-graft whereas the other treated with long duration balloon angioplasty.

The mean follow-up duration was 7.3 months (range 2-18). All patients had 1-week and 3-months follow-up visits and were clinically evaluated for effectiveness of dialysis and with US and color Doppler US for presence of residual mural thrombi, stenosis/occlusion or any pseudoaneurysm. No suture-tourniquet related stenosis, occlusion or pseudoaneurysm was observed in any patient on follow-up imaging.

Discussion

AVF recanalization is performed in the routine practice of interventional radiology and its importance is increasing due to high population of patients with end stage kidney disease. Acute thrombosis of native AVF should be treated on the same day if possible and interventional procedures include mechanical thrombectomy or manual aspiration thrombectomy and/or thrombolysis procedures [10]. Manual aspiration thrombectomy procedure has a lower cost and no need to use thrombolytic agents. However, large-bore venous sheaths and heparinization are required. Therefore, haemostasis becomes a problem after the sheath removal. In the literature, there were few studies to investigate the haemostasis for AVF interventions. In this study, we have achieved a successful haemostasis in 94% (60 of 64 procedures) with the suture-tourniquet technique. In 1 procedure, suture was broken while rotating the tourniquet. In 3 procedures of patients with ages of 65 and 71, the techniques were performed correctly, however haemostasis were not achieved. This may be due to decreasing the suture compression on the puncture site possibly related with decreased water content, turgor and loss of collagen in elder patients [11].

Vorwerk, et al. used the classic purse-string suture method to achieve haemostasis. In their study, 15 venous sheaths, ranged from 5.5 to 10 Fr, were introduced in 13 patients. 5 of them were arteriovenous grafts and the others were native AVF. The success rate of this study was 86%. Vorwerk, et al. mentioned purse-string suture advantages especially in gaining time and ease of achieving haemostasis. However, providing the optimal tension on the purse string suture is not always easy, so bleeding and rethrombosis can be occur. Also the buried suture removal may be challenging [3,6]. Zaleski, et al. [3] described suture-tourniquet technique to overcome the purse-string sutures disadvantages. They used this technique in 24 patients and most of whom had AV grafts and small-bore sheaths range from 6-7.5 Fr were used for procedures. The technical success rate of this study was 100%. They observed only minor oozing in 12.5% of patients regarding loose tourniquet. Sutures were removed easily over the plastic dilator at least 24 hours after the procedure. Our study consisted of only native AV fistulas and large-bore venous sheaths, equal or greater than 8 Fr. Our technical success rate was 94%. Most of sutures were removed in one hour after the operation without any difficulty.

Simons et al. [6] described Woggle method which was a modified purse string suture technique. They performed 161

procedures most of them were AV graft in 106 patients. Half of patients were administered IV heparin. Most commonly used 6-7 Fr sheaths. Technical success rate was 94%. In 5% of procedures, the sutures broke and for this reason, they thickened the suture for following patients. In 7% of patients, the first attempt of Woggle device was unsuccessful, haemostasis was achieved with reapplication of the device. Also haemostasis was not achieved in two patients (1%).

Suture based techniques' long term results have not been evaluated adequately. Clark, et al. [9] reported the late angiographic changes in 35 patients with 76 punctures after using suture lock device like Simons' technique for haemostasis [6]. There was no aneurysm or pseudoaneurysm at the puncture site, but bulging was seen with larger sheath sizes in the follow up period. So, they concluded that this technique might not applicable with larger sheaths. In our study, we routinely evaluated patients clinically for dialysis effectiveness and with doppler US for any chronic stenosis within three months after the procedures. Neither any pseudoaneurysms, aneurysms nor chronic puncture side stenosis regarding suture-tourniquet technique were observed.

There were also external compression methods besides the suture-based techniques [1,7]. However, it is known that external compression methods have some advantages such as lack of need for any sutures with resultant decreased risk of pain or infections. On the other hand, these techniques can also require an extra device [1] and they often need a learning curve [8]. Currently, there is no head-to-head study that compares all of these haemostatic techniques in patients with AVF thrombosis who undergo treatment using large-bore venous sheaths and high dosage of heparin.

Our study has few limitations. It is retrospective in nature and we only evaluated native AVF thrombosis, but haemodialysis grafts weren't evaluated. Patient follow-ups were done with clinical examination and CDUS but follow up venography wasn't performed for evaluation of possible complications. Finally, a longer follow-up duration is needed to evaluate the development of possible pseudoaneurysm/aneurysm.

Conclusion

The suture tourniquet technique can be safely used with low complication rates and without fistulae thrombosis after large-bore venous sheath removal following treatment of AVF thrombosis. This method can achieve the haemostasis rapidly, after which sutures can be removed easily by using the plastic tourniquet material and patients can have their haemodialysis without time loss.

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