

Percutaneous Transluminal Angioplasty of Fibrin Sheath with Removal or Exchange of Tunneled Hemodialysis Catheters

Abstract

Tunneled dialysis catheters are widely used in the patient population with end stage renal disease (ESRD) undergoing hemodialysis (HD). These patients are usually in the process of being evaluated for arteriovenous fistula formation, and a tunneled catheter is placed in the interim. Catheter maintenance and complications (including infection, displacement, or failure to dialyze) represent a significant burden for these individuals. At our institution we noted a sizable proportion of patients presenting with catheter malfunction who required intervention, with the majority shown to have fibrin sheath formation. Retrospective review of 150 patients presenting with catheter malfunction demonstrated greater than 91% developed fibrin sheath. Subsequent catheter exchange with angioplasty to disrupt the fibrin sheath was performed, and functionality of the new catheter was confirmed with repeated rapid flushing.

Bipin Saroha*

Larkin Community Hospital, Division of Interventional Radiology, Miami, FL

*Author for correspondence:

bsaroha@larkinhospital.com

Received: 02-Aug-2022, Manuscript No. OAIN-22-57863; **Editor assigned:** 04-Aug-2022, PreQC No. OAIN-22-57863 (PQ); **Reviewed:** 18-Aug-2022, QC No. OAIN-22-57863; **Revised:** 23-Aug-2022, Manuscript No. OAIN-22-57863 (R); **Published:** 30-Aug-2022
DOI: 10.37532/oain.2022.5(4).33-36

Introduction

Patients with tunneled hemodialysis catheters represent a significant percentage of those with ESRD undergoing hemodialysis. Tunneled catheters represent a potential bridging therapy that allows these patients to receive dialysis while waiting for maturation of either an arteriovenous fistula (AVF) or graft (AVG). One of the well documented consequences of tunneled catheters, and other types of central venous catheters, is the formation of a fibrin sheath (FS). These catheter related sheaths are a mixture of cellular and acellular debris which form a cast along the outer wall and the endhole of the catheter within the vein, leading to port dysfunction in terms of difficult aspiration and or high resistance to the injection of fluid. Other factors include altered flow dynamics within the vein, stasis of flow between the catheter and vein wall, and impact of the catheter tip with the vein wall. Initial thrombus sheath has been found as quickly as 24 hours post placement in autopsy reports with more organized sheaths noted as soon as 48 hours post placement [1,2]. They can lead to catheter malfunction or complete obstruction, and there has been noted correlation between FS and central stenosis as well as suggestion that disruption of FS may reduce complications associated with central venous catheters [3]. There have been multiple different methods described to treat and break up FS including pharmacologic thrombolysis and mechanical methods such as balloon angioplasty and fibrin sheath stripping [4]. Previously, the incidence of FS has been reported between 50 and 100 % [5], and the aim of the current study is to further examine what appears to be an extremely high overall prevalence of FS as well as radiographically significant stenotic lesions using venography with cine and digital subtraction angiography views.

Materials and Method

A total of 150 patients were retrospectively evaluated who underwent tunneled catheter removal or exchange between August 2019 - March 2020. At the time of each intervention,

venography was performed on 134 patients with cine and digital subtraction angiography (DSA) to evaluate for presence of fibrin sheath. The remaining 16 patients did not undergo venography with intravenous contrast due to a documented contrast allergy or recovery of renal function. A diagnostic Vena-Cava gram performed through the existing catheter prior removal, contrast fills a well-developed sheath considerably narrower than the expected diameter of the superior vena cava. When a sheath is present, contrast will track in a retrograde fashion along the catheter. Subsequently, a 12mm x 40 mm BARD ultraverse angioplasty balloon catheter over wire was then used for venous angioplasty for treatment of fibrin sheath.

Results

Of the 134 participants who underwent venography for further evaluation of fibrin sheath, 123 (91.8%) demonstrated radiographic evidence of fibrin sheath. 99 of the 150 participants (66.0%) also demonstrated a radiographically evident stenotic lesion. Of 150 total participants, 137 demonstrated a fibrin sheath and/or a waist. Out of the 16 participants that were not evaluated with venography, 10 (62.5%) showed radiographic evidence of a waist using a contrast filled angioplasty balloon. Mean time from the date of previously performed placement or exchange of catheter until the current intervention was 95.1 days. 51 out of 55 (92.7%) of catheters evaluated within 30 days of prior placement or exchange demonstrated presence of either FS or waist. A logistic regression model found no significant association ($P = 0.405$, $P > 0.05$) between fibrin sheath formation and time since placement. Of the 150 patients, 97 underwent catheter exchange, while 53 underwent catheter removal.

Discussion

Development of FS represents a significant problem in patients who require central venous dialysis access. Short-term effects include thrombogenesis, altered flow dynamics, and catheter malfunction leading to an inability to adequately perform HD. Long-term effects include the above, as well as more chronic changes such as scarring that result in vascular stenosis. A significant amount of time is required for routine maintenance of central

venous catheters and fistulas on the part of the patient, the physician performing the intervention, as well as the patient's primary care doctor or nephrologist. In addition to time, a significant economic investment is also made in the maintenance of catheters and fistulas. Although incidence has previously been quoted between 50-100%, given the results of the current study it may be more reasonable to assume a higher minimum percentage, perhaps as high as 80-100%. While performing routine catheter maintenance such as removal or exchange, it may be beneficial to adopt a "positive until proven otherwise" stance.

In addition to an overall high incidence, the study also demonstrated an alarmingly high incidence of FS and/or vascular stenosis in catheters evaluated within 30 days of placement/exchange at 92.7%. This suggests that not only do FS play a role in overall catheter malfunction, but specifically in short-term catheter malfunction. It is of utmost importance to evaluate the presence of FS at the time of catheter exchange as placing a new catheter into an existing fibrin sheath may lead to continued dysfunction.

There are several different treatment options for non-functioning HD catheters due to FS. The most widely used treatments include administration of fibrinolytic agents through the catheter and catheter stripping. Thrombolytic therapy for treatment of hemodialysis catheter malfunction due to thrombosis or catheter related sheath has been used for decades. Two basic protocols have been employed: indwelling ("lock") catheter treatments and infusion therapies. Indwelling or "lock" treatments involve administration of a volume of thrombolytic agent which only fills the catheter lumen for a variable amount of time [6]. Infusion treatments involve the infusion of variable doses of thrombolytic through the hemodialysis catheter over several hours. Multiple different thrombolytic medications like Urokinase, alteplase, and reteplase have been used with the two methods above in varying doses over the years. Newer thrombolytic agents such as recombinant-urokinase, altimeprase, and anistreplase are currently under investigation. Because the composition of the catheter related sheath has a significant cellular component, the efficacy of thrombolytics must be attributed to interaction with the associated thrombotic elements that are present.

Hemodialysis catheter exchange with or without fibrin sheath balloon disruption is performed by placing guide wires through the existing catheter into the superior or inferior vena cava, freeing the retention cuff from the surrounding tissues using blunt dissection, and removal of the catheter. Disruption of the CRS can be accomplished by advancing a modest diameter (6-8 mm) angioplasty balloon catheter and performing inflations along the previous course of the catheter. A new catheter is then advanced over the guide wires and through the existing subcutaneous tunnel. When performed using strict sterile technique, there is no increased risk for infection. This strategy has the advantage of preserving the existing venous access site. The less invasive nature and estimated lower costs of this procedure is responsible for its current widespread application.

Finally, catheter stripping may also be used in certain situations when the aforementioned interventions are unsuccessful. Treatment of occluded central venous catheters by some method of mechanical disruption has been described in the literature as early as 1983 using a straight guide wire advanced through the catheter lumen via a Y-valve under simultaneous constant suction with 100% success. Mechanical interventions such as percutaneous catheter related sheath stripping (PCRSS) with balloon disruption and catheter exchange have also been employed as a treatment for fibrin sheaths which result in occlusion or decreased blood flow rates. Multiple recent studies show PCRSS had the lowest 30-day failure rate among all the approaches including conservative and mechanical intervention. This intervention involves advancing a guide wire through the catheter and into the IVC. The femoral vein is annulated, and a snare device is advanced over the aforementioned guide wire and around the catheter. The snare device can be tightened around the catheter and pulled, which effectively strips the fibrin material from the catheter [7]. Several passes can be made utilizing this technique for better results.

Angle et al (2002) published a five-year retrospective analysis of 115 patients with 340 tunneled hemodialysis catheter fluoroscopic evaluations of which underwent one of five interventions: conservative management (aspiration/flushing), tip-deflecting guide wire manipulation, catheter exchange, PCRSS with a

snare via femoral approach, and thrombolytic infusion. Failure rates at 30 days using the five management strategies above ranged from 24% to 62% [8, 9].

Current research trials are focused on drug eluting coatings consisting of cytostatic or cytotoxic agents for central venous catheter. The characterization of the cellular basis of catheter-related sheath formation may initiate further developments in the area of catheter technologies that could include the development of materials with or without coatings that prevent, retard, or eliminate the fibrous sheath.

There are several limitations to this study, the foremost of which being relatively small sample size at a single institution. Several other metrics were not included in our data analysis such as age, ethnicity, gender, as well as underlying medical conditions. Further investigation could be conducted to determine if any demographic or environmental factors have a significant role in FS propagation.

Conclusion

Given the FS occurrence rate of 91.8% in the current study, we postulate that FS occurrence rates previously quoted as low as 50% may be grossly underestimated. In addition to causing short term catheter malfunction, they are also correlated with incidence of development of other long-term effects such as stenotic lesions. With incidence demonstrated >90% and taking into consideration possible short- and long-term complications, it is important to be vigilant in evaluating for the presence of both fibrin sheaths and stenotic lesions during routine catheter maintenance such as exchanges or removals.

Conflict of Interest

None

Acknowledgement

Special thanks to our Interventional radiological technologists Robert Alvarez, R.T. (VI) and Jesse Cortes R.T. (VI) (CT) for their expertise and assistance in participating cases.

References

1. Hoshal VL, Ause RG, Hoskins PA. Fibrin Sleeve Formation on Indwelling Subclavian Central Venous Catheters. *Arch Surg*. 102: 353-358 (1971).
2. Schwab SJ, Beathard G. The hemodialysis catheter

- conundrum: hate living with them, but can't live without them. *Kidney international*. 56: 1–17 (1999).
3. Hacker RI, Garcia LM, Chawla A *et al*. Fibrin sheath angioplasty: a technique to prevent superior vena cava stenosis secondary to dialysis catheters. *Int J Angiol*. 21:129–134 (2012).
 4. Mohamad AA, Ehwut ELS. Dialysis catheter fibrin sheath stripping: a useful technique after failed catheter exchange. *Biomed Imaging Interv J*. 8: e8 (2012).
 5. Oguzkurt L, Tercan F, Torun D *et al*. Impact of short-term hemodialysis catheters on the central veins: a catheter venographic study. *Eur J Radiol*. 52: 293–299 (2004).
 6. Chang DH, Mammadov K, Hickethier T *et al*. Fibrin sheaths in central venous port catheters: treatment with low-dose, single injection of urokinase on an outpatient basis. *Ther Clin Risk Manag*. 13: 111–115 (2017).
 7. Crain MR, Mewissen MW, Ostrowski GJ *et al*. Fibrin sleeve stripping for salvage of failing hemodialysis catheters: technique and initial results. *Radiology*. 198: 41–44 (1996).
 8. Percarpio R, Chorney ET, Forauer AR. Catheter-Related Sheaths [CRS]: Pathophysiology and Treatment Strategies. *Hemodialysis*. (2013).
 9. Angle JF, Shilling AT, Schenk WG *et al*. Utility of Percutaneous Intervention in the Management of Tunneled Hemodialysis Catheters. *Cardiovasc Intervent Radiol*. 26: 9–18 (2003).