Fibrin sheath removal from central venous catheters: an internal snare manoeuvre

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Abstract

Background. Dysfunction of haemodialysis catheters is most commonly due to the narrowing of the catheter lumen and/or formation of a fibrin sheath around the catheter tip. Reported methods for restoring patency of the catheter lumen include passage of a J-tipped guide wire, passage of a biopsy brush through the catheter, or infusion of a thrombolytic agent into the catheter. While these methods are often effective, they suffer from several limitations. We present a minimally invasive technique to remove thrombi and debris from within the lumen of a partially thrombosed haemodialysis catheter while simultaneously stripping the fibrous sheath.

Methods. A 0.089 cm nitinol wire is bent to create a loop, which is then inserted via the catheters. Upon exiting the lumen of the catheters, the nitinol wire forces a snare open, which disrupts the fibrin sheath and catches intraluminal thrombi and debris. The technique requires no anaesthesia or recovery time.

Results. Initial clinical success in our series was achieved in all patients (7/7) as evidenced by restoration of target flow rates on subsequent haemodialysis. None of the patients experienced any complications as a result of the procedure. The catheter 2-, 4-, and 6-week primary success rates were 100% (8/8), 100% (8/8), and 100% (8/8) respectively with a mean duration of 17.1 weeks (range 8–40 weeks).

Conclusions. The internal snare technique is an effective, inexpensive and minimally invasive approach to restoring patency to failed central venous access catheters.

Keywords: central venous catheters; fibrin sheath stripping; fibrinolysis; internal snare; occluded haemodialysis catheters

Introduction

Dysfunction of haemodialysis catheters is most commonly due to the narrowing of the catheter lumen and/or formation of a fibrin sheath around the catheter tip [1]. Reported methods for restoring patency of the catheter lumen include passage of a J-tipped guide wire, passage of a biopsy brush through the catheter, infusion of a thrombolytic agent into the catheter or transfemoral stripping using a snare or a tip-deflecting wire [2–4]. It has been reported that patency with catheter exchange is superior to fibrin sheath stripping [5].

While these methods are often effective, they suffer from several limitations. When passing a guide wire or biopsy brush through the catheter lumen, the amount of area covered is limited to the diameter of the wire or brush. Infusion of thrombolytic agents may have limited efficacy for older, organized thrombus. While the external snare technique is effective for removing the fibrin sheath, it requires a femoral vein puncture with associated post procedure recovery time and procedure related costs. The internal snare technique is an effective, inexpensive and minimally invasive approach to restoring patency to failed central venous access catheters.

Subjects and methods

Internal-snare procedure

The internal snare manoeuvre is performed in the angiography suite, by folding the mid-portion or distal portion of a commercial 0.089 cm Terumo wire (Terumo Corporation, Japan), back on itself in the middle, thus forming a loop. Because of its substantial elastic properties, a nitinol loop can be greatly compressed without causing permanent deformation and damage. As the loop snare is advanced, force is distributed along the fibrin sheath, thereby disrupting the fibrin sheath.

The internal snare manoeuvre is initially performed on the proximal port and is then repeated on the distal port (Figure 1). Movement of the snare in the catheter...
permits retrieval of the intraluminal thrombus and debris. Where the catheter lumen is too narrow and the wire loop cannot be introduced through the catheter, a small bend was placed at the loop of the wire with a Kelly clamp before being introduced into the catheter. Although this may exceed the elastic tolerance of the nitinol wire and produce a permanent kink, pulling one of the proximal ends of the nitinol wire, after the loop exits through the catheter, still activates the snare. To-and-fro motion in the catheter and at its tip permitted extraction of intracatheter clot and firm debris in all cases.

The technique was performed under continuous cardiac monitoring in the angiography suite by 4 interventional radiologists with 2–20 years of experience. There was no intravenous conscious sedation and, therefore, no recovery time was required.

**Subjects**

The internal snare manoeuvre was performed on nine catheters in seven patients (two catheters had two stripings each) at our institution over a period of 12 months. These nine catheters were the only ones which met the criteria for our technique. Of the nine catheters, only eight were included in our calculations for primary and secondary patency rates as one patient was lost to follow-up. All the patients had had a trial of tissue Plasminogen activator (tPA) infusion for their catheters prior to using the internal-snare. All catheters were 12.5 French Bard catheters.

**Technique**

In the first two patients, the 0.089 cm Terumo glide wire was folded approximately 20 cm from its tip. In the last five patients, the wire was folded in half, yielding better control of the snare. The clot sizes and number of passes made were reported. Patency of the catheters and confirmation of target flow rates were made by the haemodialysis team on the basis of whether the catheters could be used for haemodialysis or not. Primary and secondary patency durations were recorded and primary and secondary patency rates were calculated.

**Results**

**Technical success**

Sizes of retrieved clots ranged from 1 to 5 cm in length. On average, five to six passes (range of 4–7 passes) were made, depending on the amount of clot and debris noted in the catheter, as well as the amount of fibrin sheath surrounding the catheter.

**Clinical success**

Initial clinical success in our series was achieved in all patients (7/7) as evidenced by restoration of target flow rates on subsequent haemodialysis. None of the patients experienced any complications as a result of the procedure. The catheter 2-, 4-, and 6-week primary success rates were 100% (8/8), 100% (8/8), and 100% (8/8), respectively (Table 1), with a mean duration of 17.1 weeks (range 8–40 weeks). Patient 1 was lost to follow-up after one week with maintained primary patency. Catheter 4 remained patent for 19 weeks, was subjected to the internal snare manoeuvre again and was ultimately exchanged 2 weeks later (Table 1). Patients 2 and 4 required a catheter exchange after 8 and 11 weeks of primary patency, respectively. Catheter 3 required one internal snare procedure and remained patent for 8 weeks after which no further follow-up was obtained. Catheter 6 required two internal snare procedures and was still patent after 33 weeks of secondary patency when follow-up was discontinued (Table 1). Catheters 7, 8 and 9 had
primary patencies of 40, 16 and 20 weeks, respectively and were all still patent when follow-up was discontinued (Table 1).

**Discussion**

The formation of fibrin sheaths is considered the main culprit in the occlusion of central venous catheters and usually develops within 5–7 days after placement [6]. The etiology has been felt to be one of vascular endothelial injury, both at the catheter entry site and more distally, where the catheter tip rubs against the wall of the superior vena cava [7].

19% of all new haemodialysis patients utilize catheter-directed haemodialysis as their primary method of haemodialysis. 13% still use haemodialysis catheters at 60 days after starting haemodialysis [3]. When central venous haemodialysis catheters fail, the first attempts to restore patency are often reversal of the arterial and venous ports, followed by infusion of a thrombolytic agent [1]. Thrombolysis can be effective in restoring patency, but usually lasts approximately for a period of 6 weeks [4], at which time, patients are typically referred to interventional radiology for more definitive treatment [3,4].

We report 100% initial success (8/8) with 100% primary patency at 2 weeks, 4 weeks and 6 weeks, respectively. The data reported by Gray et al. [4] for traditional snaring were 75%, 52% and 35% for approximately the same period, with a mean duration of patency of approximately 4.5 weeks [4] compared with our primary duration of patency of 17.1 weeks (Table 2). For the traditional transfemoral snare method, Brady et al. [8] reported a technical success of 95.6% and an overall median poststripping patency of 89 days [8] compared with our median poststripping patency of 108.5 days (Table 2). Primary patency durations for the traditional transfemoral snare method range from 2.8 to 4.3 months [8–11]. Secondary patency durations are also variable, with percentages ranging from 60 to 72 at six months having been reported [10,11]. Our clinical results, therefore, are consistent with the literature, if differences in definition of patency are taken into account (flow rate of 300 or 250 ml/min for Gray et al. and Brady et al., respectively [4,8].

With the internal snare technique, the folded end of the glide wire has a tendency to spring open when it emerges from the catheter. This force is strong enough to disrupt the sheath at the catheter tip, due to the super elastic properties of nitinol. Rotating the folded portion of the wire around the tip of the catheter continues to clean the sheath from the catheter tip. When the wire is advanced through the proximal port, the folded end can be used as a snare device to strip the fibrin sleeve off of the posterior surface of the catheter (Figure 1) before a separate stripping is performed on the distal port. The entire procedure can be performed quickly with no discomfort to the patient. No intravenous conscious sedation is required, and therefore, no recovery period is necessary. Furthermore, no new needle sticks are required, since the wire is advanced through the catheter itself and not the femoral vein.

Although the technical success was high with our technique, our study was not without limitations. First of all, our sample size was quite small with seven patients in total accounting for nine catheters with one patient/catheter lost to follow-up. Further studies with a larger sample size should be performed to determine if our results are reproducible. Neither the traditional transfemoral snare method nor the internal snare technique offers a permanent solution to the occlusion of central venous catheters. Further studies will be required to determine the efficacy of our folded glide wire technique compared with that of the snare technique.

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**Table 1. Summary of patency rates using the internal snare manoeuvre**

<table>
<thead>
<tr>
<th>Catheter #</th>
<th>Patient</th>
<th>Time until catheter became thrombosed</th>
<th>Primary patency</th>
<th>Secondary patency (with second snare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Patient 1</td>
<td>unknown</td>
<td>unknown</td>
<td>unknown</td>
</tr>
<tr>
<td>2</td>
<td>Patient 2a</td>
<td>1 week</td>
<td>8 weeks</td>
<td>n/a</td>
</tr>
<tr>
<td>3</td>
<td>Patient 3a</td>
<td>4 weeks</td>
<td>19 weeks</td>
<td>2 weeks</td>
</tr>
<tr>
<td>4</td>
<td>Patient 4a</td>
<td>27 weeks</td>
<td>11 weeks</td>
<td>n/a</td>
</tr>
<tr>
<td>5</td>
<td>Patient 5a</td>
<td>&gt;10 weeks*</td>
<td>40 weeks</td>
<td>n/a</td>
</tr>
<tr>
<td>6</td>
<td>Patient 6</td>
<td>Unknown**</td>
<td>16 weeks</td>
<td>n/a</td>
</tr>
<tr>
<td>7</td>
<td>Patient 7</td>
<td>12 weeks</td>
<td>20 weeks</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*aPatient had two prior transfemoral snare procedures.

*bDuration unknown as the catheter was placed at an outside institution.

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**Table 2. Summary of selected fibrin stripping studies**

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Number of catheters</td>
<td>28</td>
<td>131</td>
<td>8</td>
</tr>
<tr>
<td>Number of stripings</td>
<td>28</td>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>Initial success</td>
<td>89%</td>
<td>95.6%</td>
<td>100%</td>
</tr>
<tr>
<td>15-day primary patency</td>
<td>75%</td>
<td>88%</td>
<td>100%</td>
</tr>
<tr>
<td>30-day primary patency rate</td>
<td>52%</td>
<td>78%</td>
<td>100%</td>
</tr>
<tr>
<td>45-day primary patency rate</td>
<td>35%</td>
<td>65%</td>
<td>100%</td>
</tr>
<tr>
<td>Median patency after stripping (days)</td>
<td>32 days</td>
<td>89 days</td>
<td>108.5 days</td>
</tr>
<tr>
<td>Complication rate</td>
<td>7.1% (2/28)</td>
<td>0% (0/131)</td>
<td>0% (0/8)</td>
</tr>
</tbody>
</table>

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We did not encounter any complications as a result of our technique. There have been a few scattered reports of infection and thrombosis following percutaneous fibrin stripping [4,10]. One area of concern is the risk of pulmonary emboli, which are potential hazards of any fibrin stripping technique, including ours. Theoretically, pieces of the fibrin sheath can become dislodged following a stripping and enter the pulmonary circulation with ensuing embolism. According to some older literature, in healthy patients, fresh thrombus is cleared from the arterial system in a matter of months [12,13]. However, incomplete resolution may take place in up to 50% of the patients, while nearly a third of the cases will have no clot lysis at all [12,13]. Therefore, sicker patients who are on haemodialysis may not be able to lyse clots as readily and are more prone to smaller emboli that are released during stripping procedures. Despite these concerns, we have found only a single case report of symptomatic pulmonary embolism following catheter stripping [14]. Moreover, Brismar et al. found that catheter removal has also been associated with pulmonary emboli [15]. Although there has only been a single report of pulmonary emboli following fibrin stripping, the risk is indeed present. However, more long-term prospective trials should be performed to quantify the risk.

In an effort to extend the life of haemodialysis catheters, while also saving resources, stripping the thrombus and/or fibrous sheath off of these catheters has become commonplace. Most often this is done with a snare through a femoral venous approach, necessitating local anaesthesia, a skin puncture, possibly some taping local anaesthesia, a skin puncture, possibly some

Conflict of interest statement. None declared.

References


Received for publication: 16.10.06
Accepted in revised form: 28.2.07