Sutures are commonly employed in non-vascular interventions in the construction of locking-loop drains or visceral wall anchors; they have generally not been used in the vascular system because of concerns that sutures may break or cut the vessel at the entry site. The purpose of this paper is to demonstrate that the proper use of 4-0 traction sutures to modify the curve of intravascular devices can be safe, inexpensive, and simplify otherwise complex maneuvers. The use of sutures intravascularly will be demonstrated in four examples.

**Intravascular Suture Snare.** The most widely used devices for retrieving intravascular foreign bodies are stone baskets and the Amplatz snare (Microvena, White Bear Lake, Minnesota). The Curry set (Cook, Inc., Bloomington, Indiana) is the simplest, consisting of a fine guide wire which is looped at the tip of a catheter. However, the wire tends to kink and is poorly visible under fluoroscopy.

The 4-0, 75 cm suture end (Tevdek, Deknatel) is securely attached to the end of a standard 0.035 inch 15J guide wire (Cook, Inc.) by forming a loop over the wire and tightening it until it is securely buried between 2 coils of the helical spring (Figure 1). The guide wire and the trailing suture are advanced through a 6 or 7 Fr catheter in the neighborhood of the foreign body until 4–5 cm of wire protrudes from the catheter tip. The diameter of the loop can be varied by advancing or retracting the guide wire while holding the suture under steady tension. Once the loop is maneuvered over the foreign body, the guide wire is pulled back to trap the errant catheter segment which can then be pulled out through the introduction sheath. A loop perpendicular to the catheter shaft can also be obtained if the wire guide-suture device is placed through a catheter with a right angle hockey-stick curve.

I have used this device for retrieving catheter foreign bodies in the pulmonary artery and right atrium before the availability of the Microvena snare, which is more efficacious but much more expensive.

**Selective Biopsy.** Standard myocardial biopsy forceps have a slight preformed curve to allow access to the right ventricle but generally poor torque-ability for reaching a specific target.

If a suture is securely tied to just below the jaws of the forceps, it can be used to arch the distal body of the forceps into varying degrees of curvature and markedly increase its maneuverability. The forceps must be threaded through an 8 Fr sheath to allow a smooth introduction along with the 4-0 suture. The forceps must be allowed to protrude at least 7 cm beyond the sheath to allow bending by suture traction (Figure 2). Although I have used this technique several times for tumor biopsy in the common bile duct, I found it also effective in the biopsy of a right atrial thrombus initially thought to be a malignancy. This technique may have applications in the right ventricle.
Suture Reshaping of Sidewinder Catheters.

Sidewinder or Simmons type catheters have a wide variety of applications for catheterization of brachiocephalic, bronchial, all abdominal visceral and iliac arteries, as well as renal and adrenal veins. Despite its superiority in performing many procedures, it is often not used because of difficulty in reforming its curve. Some of the many techniques that have evolved to facilitate reshaping include the use of left subclavian catheterization, looping it against the aortic valve, exchanging it over a guide wire which has been catheter directed over the aortic horn, bending it with a deflector wire, a “quick twist” in the descending aorta and others. Sos has devised sidewinder catheters (Angiodynamics, Queensbury, New York) which can be reformed easily in the aorta but they are too short-tipped for many applications.

A method using suture traction is simple, safe, rapid, and inexpensive. A simple knot is tied within one centimeter of the free end of a 75 cm length of 4–0 Tevdek suture and fed through the tip of the catheter for about 3 cm. The stiff end of a standard 15J flexible tip 0.035 inch guide wire is advanced retrogradely through the catheter until about 15 cm of the floppy end is left protruding from the catheter tip. The suture is now effectively held in place by a friction fit between the tapered catheter tip and the guide wire. The guide wire, catheter and trailing suture are advanced as one through a femoral introduction sheath to the mid-descending aorta. The guide wire is pulled back under fluoroscopy to position about one inch distal to the catheter tip. The Simon’s catheter can now be easily reshaped by gently pulling on the suture and advancing the catheter (Figure 3). The guide wire is removed to release and pull out the knotted suture.

We have used this quick, reliable suture technique for over 15 years with no complications. This is in contrast to the standard Simmons catheter reshaping methods which have been associated with embolic strokes, catheter knot formation, as well as the annoying time-consuming or expensive maneuvers which must be employed to reform its curve. In addition to reshaping Simmons catheters of all sizes, this method has also been used to form a loop of hockey-stick shaped catheters, PTA balloon catheters, to recurve Waltman loops, and to reshape Ben Menachem catheters (Cook, Inc., Bloomington, Indiana).

Femoral Artery Catheter Conversion from Retrograde to Antegrade.

Antegrade femoral artery catheterization is performed when it is difficult to access the SFA from the contralateral side because of severe aorto-iliac atherosclerotic disease or for PTA of distal infrageniculate lesions. Because antegrade femoral artery punctures can be difficult in patients with an overhanging pannus,
scarred groins, high bifurcations or small caliber vessels, it is possible in some cases to catheterize the ipsilateral SFA by pulling down a sidewinder catheter from the aorta. However, this is only possible if the external iliac artery is of sufficient diameter to allow the passage of the knee of the reformed catheter which can vary from 8–12 mm (Figure 4).

A femoral artery “guide wire catheter converter” was devised to overcome these problems. It resembles a short, 12 cm Rosen type guide wire with a 4-0 Tevdek braided suture securely attached to the J-end. The diagnostic aortic catheter is exchanged for a 5.5 Fr, 20 cm catheter. The device is fed J-end first into the catheter and pushed out into the iliac artery with a 0.035 inch guide wire. It is then pulled caudad by the suture until the J-tip becomes securely engaged to about 1 cm within the catheter tip. When the catheter and piggy-back wire are further pulled caudad, the proximal end of the wire will selectively engage the SFA (Figure 5). When the catheter reaches the level of the arteriotomy site, the catheter can be easily advanced antegrade into the SFA. The catheter is exchanged for an introducing sheath to permit necessary interventional procedures.

This technique was used safely in over 20 patients for PTA, thrombolysis or embolization. They were either obese, had small caliber or diseased iliac arteries, or had unexpected native or graft treatable lesions on the ipsilateral leg. There were no significant groin hematomas or unexpected separations of the sutures.

CONCLUSION

The techniques described all involve the use of an intravascular 4-0 plastic suture for traction either to reshape a guide wire, a catheter, or forceps, or to redirect a catheter. The concern that the suture could break loose and embolize and/or lacerate the artery at the entry site is put to rest by many years of personal experience with some of these techniques. Gentle suture traction prevents separation and the

Figure 3. Reshaping a Simmons catheter. (A) Following fixation of the knotted suture by the guide wire, the catheter and guide wire are advanced to the proximal thoracic aorta. (B) The guide wire tip is pulled back to within a few centimeters of the distal catheter tip. (C) The Simmons catheter curve is reformed by gently pulling on the suture and advancing the catheter. (D) The suture is removed by withdrawing the guide wire.

Figure 4. Retrograde-antegrade femoral artery catheterization can be performed either (A) from the contralateral groin, or (B) from the ipsilateral side with a sidewinder type catheter if the external iliac artery is wide enough to allow passage of catheter “knee”.

Antegrade-Retrograde SFA

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placement of a catheter introducing sheath protects the arteriotomy site. It is hoped that other applications will be devised in the future for the use of sutures for simplifying and reducing the cost of catheter or stent procedures.

REFERENCES

PANEL DISCUSSION

JUAN PARODI: It is not easy for me to understand this because I am a surgeon. But I should say that I am amazed by the ingenuity of the presentation of Dr. Cope. The only question that I have is a few days ago I tried the hemobond and the suture broke. What is the problem in the last situation if the suture doesn’t stand the pulling from the end?

CONSTANTIN COPE: That’s always a problem isn’t it? As I mentioned earlier, the suture takes 3 to 4 pounds of test pull, and the way it is made it will not loosen before it breaks. The pulling force required to reform these catheters is very small.

SOUHEIL SADDEKNI: The catheter I designed facilitates antegrade catheterization of the superficial femoral artery. The design is based on a catheter you made to convert a 0.018” wire to 0.035” for nephrostomy procedures. My catheter helps when the wire from antegrade approach of the common femoral keep selecting the deep femoral. The side hole of the catheter is positioned against the SFA and the wire is passed through the side hole. In the technique you have just described, I noticed in your last slide that there is more contrast in the deep femoral artery. It appears that we may encounter the same problem of preferential entry of the wire in the DFA. Can you control the wire when you pull down the string?

CONSTANTIN COPE: Yes. The proximal end of the wire is curved. So, if you tighten the string and turn the catheter, the device will turn together with the catheter to enter the profunda or to the SFA.

SOUHEIL SADDEKNI: So one would have to do some maneuvering.

AUDIENCE: You never discussed the technique of the double puncture of the same femoral arteries. This way you can maintain two catheters in the same artery. The retrograde catheter can use a full flow control. In this way you are able to safely maintain the retrograde catheter and control the second for distal maneuvers.

CONSTANTIN COPE: I agree with you. The purpose of this technique is to use only one femoral artery puncture to perform both aortogram and antegrade ipsilateral catheterization. We don’t need a catheter up in the aorta because we can opacify the femoral artery through the antegrade sheath during interventional procedures.

THOMAS MCNAMARA: On that Rosen wire, are you just taking one off the shelf and cutting it?

CONSTANTIN COPE: Yes. I make my own right now, but one of the companies is going to be making them commercially.