Percutaneous Retrieval of Intravascular Broken Catheter Fragments. A Novel Technique Using a Balloon

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Summary

We describe a novel technique to retrieve broken catheter fragments from the vascular tree at difficult locations using a balloon. A coronary balloon can be taken over a microwire into the catheter fragment to hold it after inflation of the balloon and then the whole assembly can be gradually taken out. We used this novel technique successfully in three patients where the snare failed to retrieve the broken catheter fragment from vascular tree.

Introduction

Interventional radiology has become very popular as a minimally invasive technique for treating various vascular diseases. At the same time breakage of various materials inside vessels and their unintentional distal migration continues to plague the radiologist. With the increasing number of interventional procedures, retrieval of broken catheter fragments has also become a frequent procedure for the interventional radiologist.

The first recorded case of intravascular catheter fragmentation and migration was in 1954¹. Surgical removal was the only method available until 1964, when non-surgical removal of a broken steel guide wire fragment from the right atrium was reported². Most of the reported cases were of retrieval of a catheter frag-

ment from the superior vena cava, right side of heart, and pulmonary artery^{3,4}. Fewer cases of intraarterial retrieval have been reported in literature, though each and every angiographer and catheterization laboratory are facing the problem of broken catheters and attempts to retrieve the fragment^{5,6}. In 1969, Curry described the standard technique of retrieving intravascular foreign bodies using loop with a wire snare⁷. Later many variations of this and also additional techniques were defined owing to the different natures and shapes of the embolized foreign bodies³.

In 1995, Tytle et al: described the 'gooseneck'-concept and the technique can be used for foreign body retrieval from microvascular system⁸. Later many authors used gooseneck snares for intravascular foreign body retrieval with great success and minimal complications^{9,10}. Graves et al. evaluated a new retrieval device in a canine model for use in small vessels with a 91% success rate¹¹. Percutaneous retrieval of intravascular foreign bodies has now become a standard method of treatment^{2-7,9-12}.

We describe a novel technique to retrieve intravascular broken catheter fragments using a balloon where the loop snare retrieval failed.

Instrumentation and Technique

We applied this ingenious balloon-assisted technique in three patients where the routine

Figure 1 Schematic diagram shows a broken catheter fragment in the right transverse sinus. Another guide catheter is placed in the jugular vein. The microwire is passed through the broken catheter fragment.

method using loop snare failed to retrieve the intravascular broken catheter fragments.

The technique is simple but very useful in some difficult cases. The devices needed are a 8F or 9F arterial sheath, a 6F/7F guiding catheter (straight or curved tip as required and decided by the configuration of the vessel where the broken catheter fragment is lodged), a 0.014/0.010 microwire and a percutaneous transluminal coronary angioplasty (PTCA) balloon of small diameter.

Technique

STEP 1: After catheter breakage, the proximal part of the broken catheter is removed. Then a new 6F or 7F straight or curved tip guiding catheter is placed in the respective vessel (figure 1A). We prefer a guiding catheter to be larger size so that it can accommodate the broken catheter fragment for easy and correct retrieval. The sheath may have to be changed to accommodate the newly placed guiding ca-

theter as desired. Then an angiogram should be done to delineate the position of the broken fragment in the vessel. Then the guiding catheter has to be advanced to place it close to the broken fragment.

STEP 2: A 0.010 / 0.014 microwire is passed through the guiding catheter and then an attempt is made to pass it through the lumen of broken catheter fragment (figure 1B). This step is very important for success of the procedure. With a little expertise, it is not difficult to negotiate the microwire through the lumen of broken catheter fragment. Sometimes different curves have to be tried so that the microwire tip can be negotiated properly. The tip of the microwire should be kept 4-5 cm distal to the broken fragment to support the fragment properly.

STEP 3: Then a small diameter rapid exchange PTCA balloon is passed over the microwire (figure 2A). When the balloon enters the broken catheter fragment, it is kept in such

Figure 2 A PTCA balloon is passed over the wire into the broken catheter fragment. The balloon is inflated to hold the broken catheter fragment. The whole assembly is being taken out.

a way that only the distal half of balloon is within the broken catheter fragment. Now, the balloon is inflated to nominal pressure of around 4-6 atmospheres (figure 2B). As the balloon inflates, the distal half of the balloon anchors the broken catheter fragment and it is aligned with the balloon's proximal inflated segment.

STEP 4: Now very carefully the whole balloon-broken catheter fragment assembly is withdrawn over the microwire inside the guiding catheter or kept just distal to it (figure 2C). It is better if the whole assembly can be withdrawn inside the guiding catheter so that negotiation of tortuous vessels becomes easy. Then it is taken out gradually through the sheath.

Case Reports

Case 1: The first patient was a 35-year-old man who presented with a sudden onset of right frontal headache followed by left focal seizure and then weakness of left upper and lower limbs. MRI scans of brain showed superior sagittal sinus thrombosis and haemorrhagic infarct of the right posterior parietal region. He was not responding to heparin treatment and was taken for thrombolysis. Through the right femoral venous route a 6F Fasguide catheter (Boston Scientific Corporation, USA) was passed through an 8F sheath and was advanced up to the distal part of right transverse sinus over a teflon coated exchange wire. There was some difficulty in negotiating the bends of the sigmoid sinuses because of tortuosity. After removal of the guidewire, it was found that the distal part of the guiding catheter was moving freely in the horizontal part of the transverse sinus as it had broken and migrated distally. Then a 25 mm loop snare (Amplatz Gosse Neck Snare, Bard Inc., USA) was passed through the catheter and an attempt made to remove the broken end but failed as it could not hold the catheter fragment tightly and negotiate the bends. Then the broken guiding catheter was replaced by a new 8F Vistabrite guiding catheter (Cordis Corporation, Miami, FL). A Choice floppy wire 0.014 (SCMED, Boston Scientific Corporation, USA) was passed and negotiated through the lumen of the broken catheter fragment and was passed slightly distally to support the broken segment by the wire. Over the microwire a 2.5 mm

Figure 3 The broken catheter fragment is seen in the transverse sinus. A microwire is passed through that then a balloon is passed over the wire in the broken catheter fragment (Case 1). Then balloon was inflated and the assembly taken out (not shown).

Maxxum percutaneous transluminal coronary angioplasty (PTCA) balloon (SCMED, Boston Scientific Corporation, USA) was passed and was kept in such a way that the distal 60-70% length of the balloon was within the lumen of the broken catheter fragment (figure 3). The balloon was inflated so that it held the broken catheter tightly. Now, the balloon along with the wire was gradually withdrawn proximally just up to the distal end of the guiding

Figure 4 The broken catheter fragment is in the left external iliac artery. A snare was used to retrieve it but failed.

Figure 5 Microwire and balloon are passed through the broken catheter fragment. The balloon is inflated and the whole assembly taken out.

catheter. Then the whole assembly was taken out gradually through the 8F sheath under fluoroscopic control. There was no complication related to this procedure as revealed in the post-procedural angiogram.

Case 2: The second case was 23-year-old woman who had superior sagittal sinus thrombosis and left frontoparietal haemorrhagic infarct. She failed to respond with conservative management and was taken for thrombolysis. During thrombolysis the distal part of a 6F Fasguide guiding catheter was broken at the junction of the braided and non-braided por-

tion and was lying in the sigmoid sinus. Attempts were made to retrieve it with a snare but failed. Then the broken guiding catheter was replaced by a new 8F Vistabrite guiding catheter (Cordis Corporation, Miami, FL.). The rest of the procedure was performed as in the first case and the same materials were used. There were no complications.

Case 3: The third case was 43-year-old man who had exertional chest pain and the patient was scheduled for PTCA. During manipulation, the distal end of a 7F Judkin's left coronary catheter (Cordis Corporation, Miami, FL.) got broken in the descending aorta and descended to the aortic bifurcation. The loop snare technique was attempted to retrieve the fragment but failed (figure 4) as the broken fragment did not enter the sheath with the snare because of non-alignment of its end with that of sheath. There was fear that forceful pulling would have further fragmented the broken segment. For this reason the balloon-assisted technique was used to retrieve it. The arterial sheath was changed to a larger 8F sheath. A Choice 0.014 wire (SCIMED, Boston Scientific Corporation, USA) was passed through the broken catheter fragment and then a Maxxum PTCA balloon (SCIMED, Boston Scientific Corporation, USA) was passed over the wire and half the length kept inside the broken fragment (figure 5). The PTCA balloon was inflated to hold the fragment tightly and the whole balloon guide catheter assembly was taken out through the sheath. The post procedural angiogram did not reveal any abnormality in abdominal and pelvic vessels. The whole sequence is schematically shown in figure

Figure 6 A broken catheter fragment is seen in the left external iliac artery. The snare is seen to hold the fragment but alignment with the sheath is not perfect. A larger size sheath is inserted. A microwire is passed through the broken catheter fragment. A balloon is passed over the wire. The balloon is inflated and the whole assembly is taken into the sheath.

6. Percutaneous removal of the broken fragment was successful in all our patients where the loop snare retrieval technique had failed. There was no procedure-related complication.

Discussion

With the increasing use of indwelling catheters and endovascular devices, the removal of broken catheters and other intravascular foreign bodies has become common to interventional radiologists. Mostly the foreign bodies are encountered in the superior vena cava, right ventricle or pulmonary artery^{3,13}. They are found less frequently on the arterial side^{3,4,9-12}. The site of foreign embolization depends on the route of entry and their final position depends on the length, stiffness and shape of the material and the pattern of the vascular system¹³.

Long catheter fragments on the venous side may lodge partially in right cardiac chambers and the remaining part either in the vein or pulmonary artery. Occasionally small fragments migrate to the distal pulmonary circulation and were difficult to retrieve in that location. Foreign bodies on the arterial side are usually found in the distal circulation owing to flow-related migration. Heavier material such as a guidewire fragment migrates less frequently than catheters and they eventually become fixed to the vessel wall because of their thrombogenicity¹³.

Surgical removal of an intravascular foreign body carries a high morbidity rate especially in sick patients¹⁴. If left unremoved, they carry a high morbidity and mortality of up to 71%^{3,6}. Therefore, percutaneous removal has gained wide acceptance because it is safe and associated with less morbidity. Since the first report of percutaneous removal of a foreign body in 1964, various approaches have been described in the literature^{3,6,13}. Amongst these, the loop snare technique is the widely accepted method of retrieval of foreign bodies from both arterial and venous systems. Egglin et al. reported retrieval of 35 intravascular foreign bodies of different types like coils, stents, vena cava filters, etc. Retrieval was successful in 97% of cases with no complications¹². Savage et Al. reported their eight-year experience of retrieval of chronic intravascular foreign bodies of around three months duration without any long-term sequelae⁹.

Although devices such as loop snare, baskets and forceps have been quite successful, they are

not without failures and limitations. Several unsuccessful attempts to retrieve intravascular foreign bodies using snares have been reported in the literature. Various reasons have been attributed to these failures. Availability of no free ends for looping^{15,16} were responsibilities for some cases. Rossi¹⁷ felt his loop retrieval failed because he was on a different plane with reference to the fragment. Bloomfield¹³ experienced two failures and Steiner et Al.¹⁸ were unsuccessful in snare attempts made through the jugular veins. Few complications like cardiac arrhythmia were reported with the snare technique¹³.

In our cases attempts to remove the catheter fragments with a snare failed because it was not possible to grab the broken fragment as the fragments were in a difficult plane to snare it. So, we attempted our technique using a coronary angioplasty balloon. It was very useful when the snare technique failed. We used the balloon to hold the broken catheter fragment for retrieval. It is very important to inflate the balloon when it is just half inside the broken catheter fragment for proper alignment of the fragment with the proximal guiding catheter or sheath. If the balloon inflates distally inside the broken fragment then the proximal part of curved fragment will not align itself with the guiding catheter or sheath and it will not be possible to take it out. So it is very important to keep the proximal half or one third length of balloon out of the broken catheter fragment when inflated so that the broken catheter becomes continuous with the balloon after inflation and the distal part of the fragment remains free and supported over the microwire over which balloon was passed. Another step, which is important in this technique, is the passage of a 0.014 or similar wire through the broken fragment over which the balloon has to be passed. The wire helps to stabilize the broken catheter fragment so that the balloon can be easily passed onto it. The whole success of this technique lies in this step. It seems difficult to pass the wire through the lumen of the broken catheter fragment in a distal vascular tree. But after stabilization of the wire with the guiding catheter, we were able to negotiate it through the catheter fragment in all our cases. Once the balloon is inflated inside the broken fragment, the balloon can be kept just distal to the guiding catheter or it can be withdrawn inside the guiding catheter if it is sufficiently wide to accept the diameter of the broken catheter frag-

ment and then the whole system can be taken out through the sheath. This technique was used successfully in all our cases. However, passing a wire through a fragment is certainly not always feasible, so this technique is likely to be of value in selected cases. We consider our technique highly safe as no procedure-related complications were encountered.

The junction of the braided and non-braided portion seems to be the weakest part of the distal end of a catheter because in our first two cases the catheter broke at that point while negotiating difficult bends. The placement of guiding catheters is necessary in those places to give sufficient support to the microcatheters for distal navigation. The catheters used in our cases were new ones but in some centers catheters are being repeatedly used after sterilization. Ionizing radiation is deleterious to polyurethane used in some catheters. Repeated use of catheters can cause catheter wall delamination, tip separation and make them prone to iatrogenic accidents. Broken catheter fragments are prone to further fragmentation espe-

cially when retrieval is attempted from an artery. Embolized fragments lodged in the vascular system should be removed whenever reasonably possible. Percutaneous retrieval should be attempted before surgery because it is safe, simple and usually has no complications.

In a rapidly advancing technologic field such as interventional neuroradiology, a system for the retrieval of malpositioned or embolized foreign objects is critical. Although the optimal retrieval device is not yet available, snares appear to be successful in the majority of cases¹². Our technique with balloon assistance can be tried in selected cases and we feel interventional radiologists must be familiar with a variety of techniques to deal with the expanding spectrum of intravascular foreign bodies currently encountered.

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