Findings of an Intravenous Catheter Fragment in the Vein Using the 3D Image Reformations of MDCT

Dae Cheol Kweon*, Beong Gyu Yoo†, Sung Hwan Yang†, Jeong Goo Kim§

*Department of Diagnostic Radiology, Seoul National University Hospital, †Department of Radiotechnology, Wonkwang Health Science College, ‡Department of Prosthetics & Orthotics, Korean National College of Rehabilitation & Welfare, §Department of Radiological Science, Hanseo University

Catheter fragment and embolism are both potentially serious complications associated with the use of an intravenous (IV) catheter for contrast media bolus injection, and may be followed by serious or lethal sequelae. Though catheter fragment is a rare complication of IV catheter insertion, especially in peripheral veins, CT can be used to detect residual fragment. This study demonstrates the utility of MDCT to localize a small, subtle peripheral venous catheter, which can be easily reformatted of MDCT reformations. Various 3D techniques such as MPR and MIP, volume rendering, and shaded-surface displays are currently available for reconstructing MDCT data. Advances in MDCT technology contribute substantially to the detection and accurate localization of smaller IV catheter fragment.

Key Words: 3D reformations, Intravenous catheter, Computed tomography

INTRODUCTION

Contrast material administration during multi-row detector computed tomography (MDCT) scanning is typically accomplished using a power injector, and the extravasation of contrast material is a potential complication when a mechanical power injector is used to rapidly inject large volumes of contrast. The commonest complications associated with the use of an IV catheter and a mechanical injector, are contrast extravasation,[1] perivascular soft tissue swelling, and compartment syndrome.[2]

Catheter fragment and embolism are both potentially serious complications associated with the use of an intravenous (IV) catheter for contrast media bolus injection, and may be followed by serious or lethal sequelae.[3] Traditionally, plain radiography has been used to detect larger foreign bodies, though more recently MDCT has been used to localize small objects.[4]

The objectives of the present study were to access the quality of 3D reformations of IV catheter fragments in the peripheral vein obtained with an available MDCT scanner. We studied our initial experiences in 8 and 16 MDCT for the evaluation of IV catheter fragment, in which CT scanning with 3D reconstruction proved a valuable tool for localizing and retrieving an IV catheter fragment.

Submitted September 4, 2006, accepted September 25, 2006.
Corresponding Author : Dae Cheol Kweon, Department of Diagnostic Radiology, Seoul National University Hospital, 28, Yeongeon-dong, Jongno-gu, Seoul 110-744, Korea
Tel: 02)2072-3687 Fax: 02)3672-4948
E-mail: kdc@radiol.snu.ac.kr

SUBJECTS AND METHODS

1. Patient selection

Two patients having were the broken IV catheter region scanned with MDCT (Table 1). First, a 59-year-old man with gastric cancer underwent MDCT scanning. Briefly, an 18-gauge Teflon IV catheter (diameter, 1.3 mm; length, 30 mm; BD IV Catheter; Becton Dickinson Korea, Seoul, Korea), was inserted into a metacarpal vein of the right hand by a registered nurse. Second, a 52-year-old woman was admitted to the neurosurgery service for several weeks. She had an 18-gage Teflon IV catheter in her right cephalic vein, and upon removal it broke off at the skin.

Table 1. Patients of IV catheter fragment in the peripheral vein.

Case	Age	Gender	IV Catheter		
			Gage	Site	Fragment length (mm)
1	59	Male	18	RT. dorsal metacarpal vein	7.30
2	52	Female	18	RT. cephalic vein	26.97

2. Radiography and CT technique

In the 59-year-old man, contrast-enhanced CT then was performed using 16 MDCT scanner (Somatom Sensation 16; Siemens Medical Solutions, Erlangen, Germany) by injection 100 mL of iopromide (Ultravist 370; Schering, Berlin, Germany), administered using a power injector (Stratton; Medrad, Indianola, PA) through the 18-gauge Teflon IV catheter inserted into the vein (flow rate of 2.0 mL/sec; pressure of 221 psi).

Scanning was performed with the patient in a supine position for 60 seconds after injection initiation, which corresponded to the venous phase. During and after contrast administration, the patient complained of no symptoms or no pain in his hand, and after scanning the IV catheter removed from the metacarpal vein by the nurse. The nurse then noticed that the IV catheter had fractured, and notified it to the supervising radiologist. The patient was then closely monitored and asked to retain the same supine posture. Vascular surgery service personnel were then consulted to evaluate the status of the IV catheter fragment, and as a result the patient was scheduled for metacarpal vein exploration and IV catheter fragment removal. To localize the missing IV catheter fragment, a CT scan of the hand was performed. The metacarpal area where the catheter had been inserted, was imaged using a sixteen-detector row spiral CT scanner with a 146 mm field of view, 1.0 mm slice thickness, 0.5 mm reconstruction interval, at 120 kVp, 100 mA, a pitch of 1.25, and a 0.5 seconds gantry rotation time.

In the 52-year-old woman, an anterior-posterior and lateral X-ray did not clearly reveal the catheter fragment in the region of the right forearm, and then the area by the IV catheter fragment was imaged with an eight-detector row spiral CT scanner (Lightspeed Ultra; GE Medical Systems, Milwaukee, WI) with a 124 mm field of view, 1.3 mm slice thickness, 1 mm reconstruction interval, at 140 kVp, 160 mA, a pitch of 1.25, a 0.5 seconds gantry rotation time. Unenhanced images were obtained to the distal forearm inserted IV catheter, which was used to determine the scan of the CT.

All thin-section axial images were transferred to a workstation running a PC-based 3D reconstruction program (Rapidia 2.8; Infinitt, Seoul, Korea). An experienced radiological technologist performed 3D reconstruction with multi-planar reformation (MPR), MIP, volume rendering and surface shade display (SSD) reconstructions. Our case protocol for this CT study written informed consent was obtained from the patient.

RESULTS

In both patients, the broken IV catheters were clearly shown in the 3D reconstructed images. In one patient, the fragment IV catheter was located metacarpal vein. The axial (Fig. 1a), coronal (Fig. 1b) and sagittal (Fig. 1c) MPR images obtained of the hand demonstrated the 7.3 mm long hyper-attenuated residual IV catheter fragment in the metacarpal vein. A sagittal MPR image showed contrast extravasation around the hyperattenuated IV catheter in the dorsum of the right hand (Fig. 1c).

The IV catheter fragment of 3D volume rendering was optimized for the reconstruction: 100% opacity level, 172~1,350 HU threshold range (Fig. 1d). SSD image demonstrates the existence of the IV catheter. The IV catheter fragment was measured with approximately 7.04 mm long at 3D SSD image (Fig. 1e).

3D volume rendering of the CT data clearly demonstrates the IV catheter fragment (arrow) in the metacarpal vein of the hand. Volume rendering was optimized for the reconstruction: 100% opacity level, 87~1,265 (Fig. 1f) and 26~1,024 (Fig. 1g) HU threshold range. 3D volume rendering images were created from the 1 mm thick axial data set, and clearly demonstrated the 7 mm fragment in the dorsal metacarpal vein

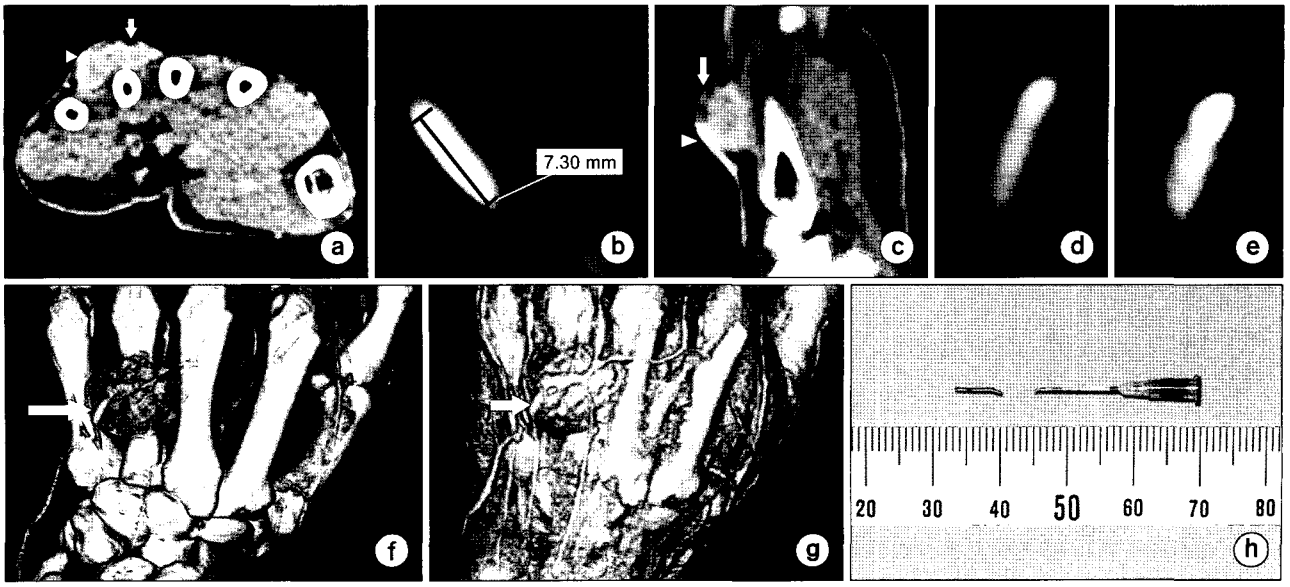

Fig. 1. A 59-year-old man with extravasation of contrast medium and IV catheter fragment in the right dorsal metacarpal vein. (a) Axial CT scan of the right hand demonstrates the metacarpal vein resident IV catheter fragment (arrowhead) and extravasation (arrow). (b) Coronal MPR image demonstrates the IV catheter. The IV catheter fragment was approximately 7.3 mm long at 3D MPR image. (c) Sagittal MPR image shows swelling (arrow) around the radiopaque IV catheter fragment (arrowhead) in the right dorsal hand. (d) IV catheter fragment of 3D volume rendering was optimized for the reconstruction: 100% opacity level, 172~1,350 HU threshold range. (e) SSD image demonstrates the IV catheter. The IV catheter fragment was approximately 7.04 mm long at 3D SSD image. (f) Three dimensional volume rendering of the CT data clearly demonstrates the IV catheter fragment (arrow) in the metacarpal vein of the hand. Volume rendering was optimized for the reconstruction: 100% opacity level, 87~1,265 HU threshold range. (g) Three dimensional volume rendering of the CT data clearly demonstrates the IV catheter fragment (arrow) in the metacarpal vein of the hand. Volume rendering was optimized for the reconstruction: 100% opacity level, 26~1,024 HU threshold range. (h) Close-up photograph shows of the two ends of the 7 mm IV catheter fragment (left) of retrieved from the dorsal metacarpal vein and 25 mm (right) fragment IV catheter show that both are with blood identified.

of the right hand (Fig. 1h). The patient was referred to the vascular surgery service and the fragment was successfully removed via a minimal incision.

In the other patient, radiography did not clearly reveal the IV catheter fragment in the region of cephalic vein (Fig. 2a). The broken IV catheter could be clearly seen in all imaging planes; transverse (Fig. 2b), coronal (Fig. 2c), sagittal (Fig. 2d). Volume rendering parameters were subjectively selected for optimal visualization of the IV catheter fragment. Volume rendering was optimized for the reconstruction: 100% opacity level, 0~667 (Fig. 2e) and 136~1,314 (Fig. 2f) HU threshold range. Volume rendering image demonstrates the IV catheter. 3D volume rendering images clearly shows of approximately 26.97 mm fragment in the cephalic vein of the right distal forearm (Fig. 2f) and retrieved IV catheter fragment (Fig. 2g). Among these, axial images were most helpful in identifying the broken IV catheter.

This study demonstrates the utility of MDCT reformations to clearly detect and localize small, subtle broken IV catheter, which can be easily missed on radiography. These 3D reconstruction findings were well collated with the findings during surgery.

DISCUSSION

Bolus iodinated contrast media injections have become the norm for CT angiography and multiphasic CT scans, and a power injector and IV catheter are frequently used to deliver contrast materials. Fortunately, catheter fracture is a rare complication of IV catheter insertion, especially in peripheral veins, and if it occurs several imaging modalities, such as plain radiography, ultrasonography or CT can be used to detect residual fragments.[5] Plain radiography is commonly used in emergency departments in cases of IV fragment

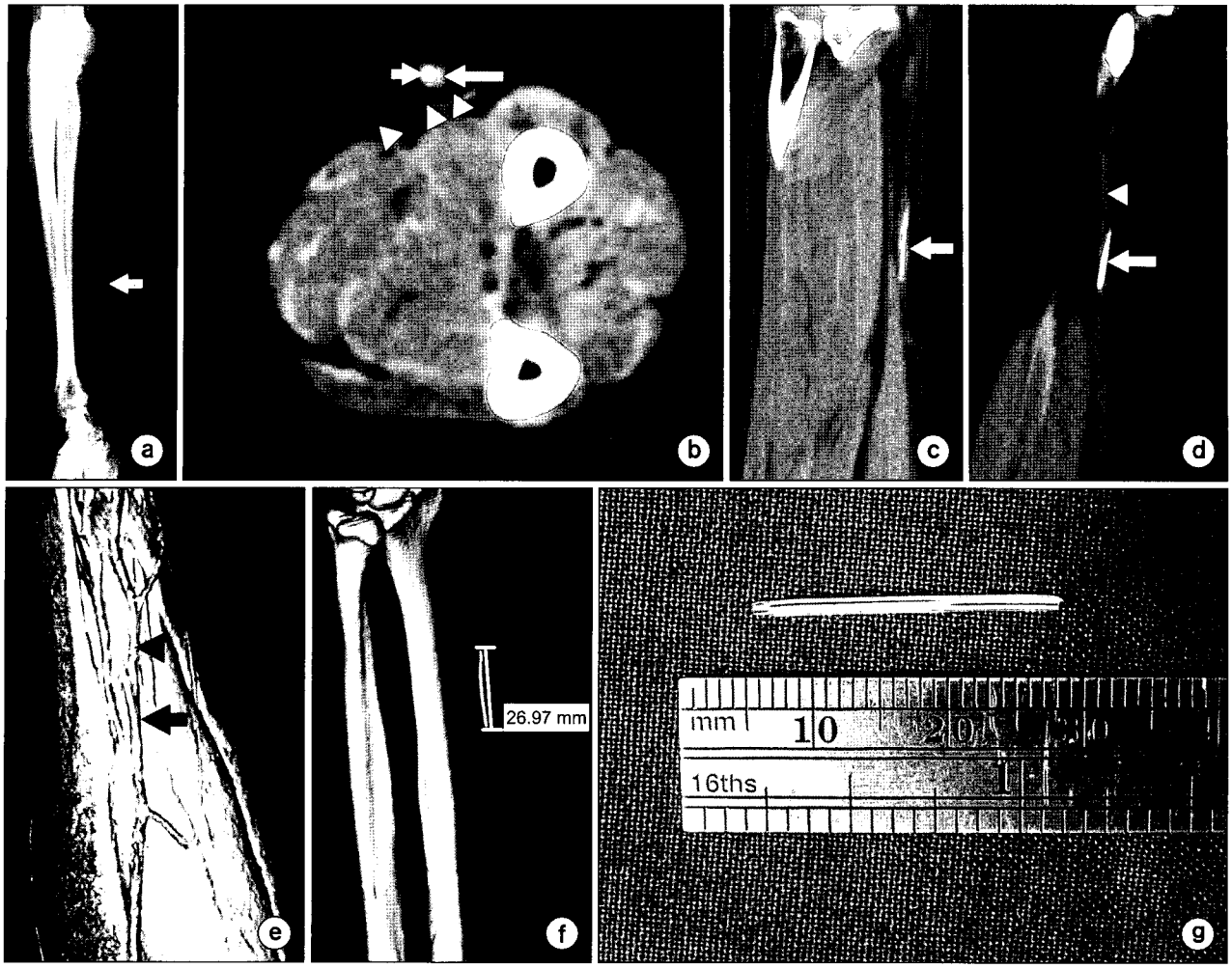

Fig. 2. A 52-year-old woman, IV catheter fragment in the cephalic vein of the right forearm. (a) Radiography showing the IV catheter fragment (arrow) lodged in the distal right forearm. (b) Transverse CT scan shows of the right forearm demonstrates the cephalic vein (long arrow) left IV catheter fragment (arrow) and air-bubble (arrows). (c) Coronal MPR image demonstrates the IV catheter. The IV catheter fragment was long at 3D MPR image. (d) Sagittal MPR image shows air-bubble around the radiopaque IV catheter fragment (arrow) in the cephalic vein (arrowhead) of the forearm. (e) Three dimensional volume rendering of the CT data performed at the time of the study clearly demonstrates a IV catheter fragment (arrow) in the cephalic vein (arrowhead) of the right forearm. Volume rendering was optimized for the reconstruction: 100% opacity level, 0~667 HU threshold range. (f) Volume rendering image demonstrates the IV catheter. The IV catheter fragment was approximately 26.97 mm long at 3D image. Volume rendering was optimized for the reconstruction: 100% opacity level, 136~1,314 HU threshold range. (g) Photograph shows of the retrieved IV catheter fragment.

involvement,[6] although in most cases of catheter fracture, distal catheter fragments can be localized by plain radiography and successfully removed via minor incisions. However, if the fragment is small (<1 cm), it may not be easily detected by plain radiography.[7] In the 52-year-old woman, X-ray the plain radiography showed a small IV catheter fragment in the distal forearm that measured with approximately 26.93 mm in leangth (Fig. 2a). However, radiography did not clearly reveal the IV catheter fragment in the region of the right forearm.

The utility of MDCT for delineating foreign bodies and determining the extent of a complicated pathology has been demonstrated in many organ systems.[8] Various 3D techniques, such as, MPR, MIP, volume rendering, and SSD are currently available for reconstructing MDCT data.[9,10] In the present case, thin-section axial images identified the IV catheter fragment, and volume rendering and MPR images provided its

precise localization and a better understanding of the anatomic relationships between veins and adjacent bones and soft tissues (Fig. 1b, c, d). Coronal MPR produced by MDCT supplied good or excellent quality images and provided diagnostic information. Our results lead us to believe that corona MPR imaging (Fig. 1b, 2c) will be deemed valuable in the clinical determination of diffuse and abnormalities and that decision making patients care will benefit from this modality.[11]

The intravenous catheter used in the present case was made of polytetrafluoroethylene (Teflon) and its surface was coated with barium sulfate five stripes. Therefore, the catheter fragment was well displayed in volume rendering images because of its high attenuation. This study is, to the best of our knowledge, the first trial to demonstrate the use of CT image reconstruction to evaluate an IV catheter fragment. The size, shape, and precise location influences the decision whether to perform surgical operation or whether to attempt IV catheter fragment retrieval. The patient was referred to the vascular surgery service and the fragment was successfully removed via a minimal incision.

CONCLUSION

In conclusion, IV catheter fragment can be difficult to visualize on plain radiographs, but MDCT scanning and 3D reformations should be considered to identify broken catheter location in the peripheral vein and guided surgery with respect to the optimal incision site for fragment removal.

REFERENCES

1. **Powell CC, Li JM, Rodino L, Anderon FA**: A new device to limit extravasation during contrast-enhanced CT. Am J Roentgenol 174:315-318 (2000)
2. **Benson LS, Sathy MJ, Port RB**: Forearm compartment syndrome due to automated injection of computed tomography contrast material: case report. J Orthop Trauma 10:433-436 (1996)
3. **Shannon FL, McCroskey BL, Moore EE, Moore FA**: Venous bullet embolism: rationale for mandatory extraction. J Trauma 27:1118-1122 (1987)
4. **Gschwind CR**: The intravenous foreign body: a report of 2 cases. J Hand Surg 27A:350-354 (2002)
5. **Gabelmann A, Kramer S, Gorich J**: Percutaneous retrieval of lost or misplaced intravascular objects. Am J Roentgenol 176:1509 -1513 (2001)
6. **Vadlamani P, Dawn B, Perry MC**: Catheter fracture and embolization from totally implanted venous access ports. Angiology 49:1013-1016 (1998)
7. **Weiss CR, Fishman EK**: Multidetector 3D CT of pulmonary embolism of a peripheral intravenous line. Emergency Radiology 11:247-249 (2005)
8. **Horton KM, Fishman EK**: Volume-rendered 3D CT of the mesenteric vasculature: normal anatomy, anatomic variants, and pathologic conditions. Radiographics 22:161-172 (2002)
9. **Addis KA, Hopper KD, Iyriboz TA, Liu Y, Wise SW, Kasales CJ, Blebea JS, Mauger DT**: CT angiography: in vitro comparison of five reconstruction methods. Am J Roentgenol 177:1171-1176 (2001)
10. **Li AE, Fishman EK**: Evaluation of complications after sternotomy using single- and multidetector CT with three-dimensional volume rendering. Am J Roentgenol 181:1065-1070 (2003)
11. **Arakawa H, Sasaka K, Lu WM, Hirayanagi N, Nakajima Y**: Comparison of axial high-resolution CT and thin-section MPR for diagnosis of diseases of the pulmonary parenchyma. J Thorac Imaging 19:24-31 (2004)

정맥내의 IV 카테터 조각의 3D MDCT 재구성 영상

*서울대학교병원 진단방사선과, †원광보건대학 방사선과, ‡한국재활복지대학 의료보장구과,
§한서대학교 방사선학과

권대철* · 유병규† · 양성환‡ · 김정구§

전산화단층촬영에서 조영 증강을 위한 조영제 주입은 정맥내에 삽입한 카테터를 통해 자동주입기로 주입하고 있다. 정맥내에 위치한 카테터를 제거 하는 도중에 IV 카테터가 부러져 정맥내에 남아 있는 카테터의 조각은 환자에게 순환기 질환의 위험을 초래할 수 있다. CT 검사 중에 정맥내에 카테터 조각이 남아있는 2명의 환자를 대상으로 카테터의 크기 및 위치를 정확히 확인 하기 위해 MDCT를 이용하여 정맥내 주사부위를 스캔하였다. 3D 재구성은 MPR, MIP, 볼륨렌더링, SSD 등으로 구성하였다. 정맥내에 위치한 카테터 조각을 MDCT로 스캔한 데이터를 3D 재구성으로 정맥내의 위치 및 크기를 확인하였고, 카테터 조각을 제거하는데 일조하였다.

중심단어: 3차원 재구성, 정맥내 카테터, 전산화단층 촬영