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Extravasation Injury of Contrast Media in the Neck and Thorax During MDCT Scanning with 3D Image Reformation Findings

—CT검사에서 조영제의 혈관외유출에 의한 목 및 흉부 손상의 3차원 재구성 영상—

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— Abstract —

Contrast media may cause tissue injury by extravasation during intravenous automated injection during CT examination. Here, we present a study in which contrast media extravasation was detected and localized in the neck and thorax by three-dimensional(3D) CT data reformation. The CT studies of the extavasation site were performed using a 3D software program with four different display techniques axial, multi planar reformation(MPR), maximum intensity projection(MIP), and volume rendering displays are currently available for reconstructing MDCT data. 3D image reconstructions provide accurate views of high-resolution imaging. This paper introduces extravasation with the MDCT and 3D reformation findings of contrast media extravasation in neck ant thorax. The followed injection of the external jugular vein into an existing intravenous catheter and a large volume of extravasation was demonstrated on by 3D MDCT.

Key Words : 3D imaging, Jugular vein, Contrast media, Extravasation, Computed tomography

Ⅰ. Introduction

Contrast media administration during multi-detector computed tomography(MDCT) scanning is typically accomplished using a power injector, and the extravasation of contrast media is a potential complication when such an injector is used to rapidly inject large volumes of contrast media. The commonest complications associated with the use of an intravenous(IV) catheter and a power injector, are contrast extravasation[1], perivascular soft tissue swelling, and compartment syndrome[2]. Tissue damage resulting from extravasated contrast media is caused by the direct toxic effect of the agent. Compartment syndrome may also occur if a sufficient amount of contrast media leaks into the surrounding skin and subcutaneous tissues[3]. Moreover, skin necrosis is a potential complication when power injectors are use to rapidly inject large volume of contrast media.

CT studies of the extravasation site were performed using a three dimensional(3D) software program and

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four different display techniques, i.e., axial, multi-planar reformation(MPR), maximum intensity projection (MIP) and volume rendering. This study shows that complete evaluations of contrast medium extravasation areas are possible using all four techniques. In order to make a diagnosis of serious extravasation incident, medical personnel need to be aware of its seriousness.

To our knowledge, no reports are available concerning the usefulness of MDCT for reformation from contrast media extravasation in a large population. Thus, the purpose of our study was to evaluate retrospectively the use of MDCT for contrast media extravasated into the neck and thorax. The followed injection of the external jugular vein into an existing intravenous catheter and was demonstrated on by 3D MDCT.

Ⅱ. Patient Data and MDCT Scanning Protocol

1. Patient Demographics

A 60-year old man was referred for lower extremity CT angiography of his leg because of suspected arteriosclerosis. An 18-gauge Teflon IV catheter(BD IV Catheter ; Becton Dickinson Korea, Seoul, Korea), was inserted into an external jugular vein of the right neck. Our institutional review board does not require approval or patient informed consent for CT scanning of previous obtained image data.

2. Contrast Media Administration and CT Scanning

Contrast-enhanced CT was then performed using a sixteen MDCT scanner(Somatom Sensation 16 ; Siemens Medical Solutions, Erlangen, Germany) using 120 mL of iopromide(Ultravist 370 mg I/mL, Schering, Berlin, Germany), which was administered using a power injector(Stratton ; Medrad, Indianola, PA, USA) through the inserted 18-gauge IV catheter (flow rate 3.5 mL/sec). A bolus tracking method was used routinely to achieve optimal synchronization of contrast medium flow and scanning. Bolus tracking system[4] acquisition was performed at a stationary level in the abdominal aorta using a 1.5 collimated slice, one image was taken per second for 40 seconds(Fig. 1). Time to peak enhancement at this level(HU ; 100) was determined by region-of-interest analysis and a contrast media elapsed time of 19 seconds(Fig. 2).

Scanning was performed with the patient in a

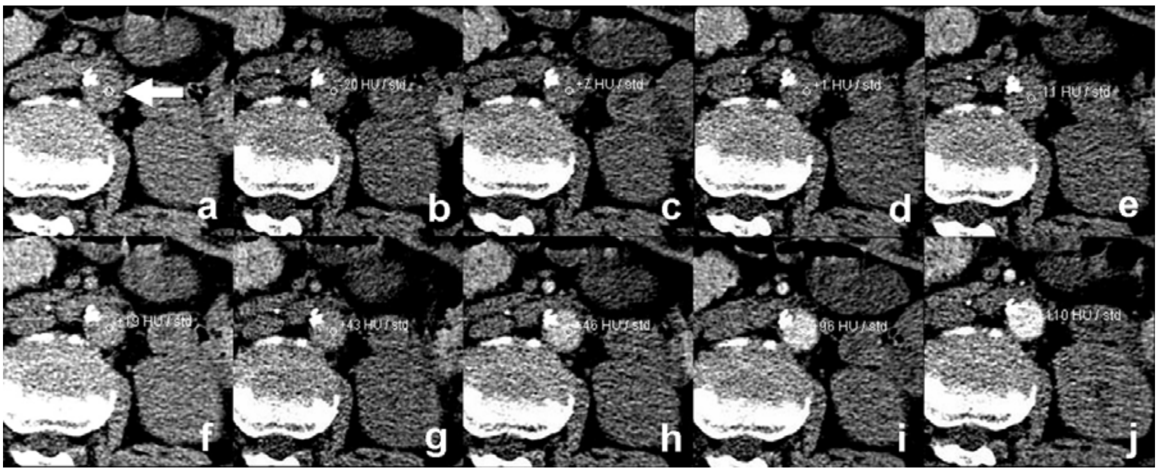


Fig. 1. Once the injection is started(a ; 0 HU), the bolus tracking software measures attenuation values of Hounsfield unit(HU)(b ; -20, c ; 7, d ; 1, e ; -11, f ; 19, g ; 43, h ; 46, i ; 96, j ; 110) within one abdominal aorta(arrow), and the spiral scan is automatically started as soon as a threshold of 100 HU is exceeded

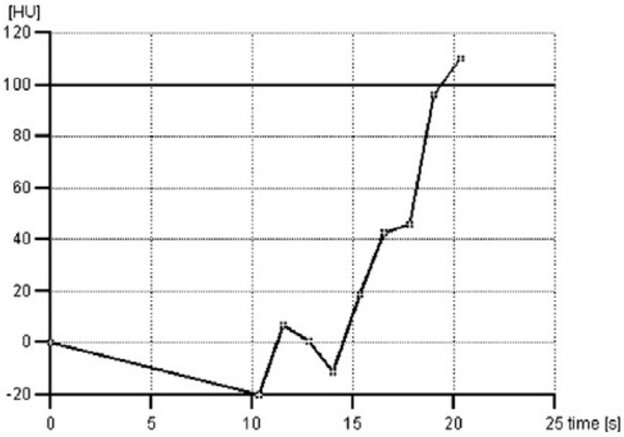


Fig. 2. Photography results of a real−time of bolus tracking system in patient

supine position after injection initiation, corresponded to the arterial and venous phases. During and after contrast administration, the patient complained of symptoms and pain in his neck. After scanning the IV catheter was removed from the external jugular vein by a physician. Approximately 120 mL of contrast media had extravasated from the right external jugular vein during the CT examination. The supervising radiologist was notified immediately, and a plastic surgeon was consulted to evaluate the extravasation.

3. Acquisition of CT Data and 3D reformation

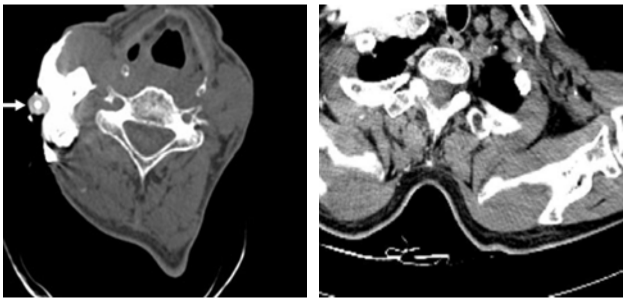
To localize the extravasation, a CT scan of the neck and thorax was performed. CT scout shows contrast media extravasation into the surrounded of the neck and thorax(Fig. 3). The jugular vein, in which the IV catheter had been inserted, was imaged using a sixteen MDCT scanner with a 245 mm field of view, 1.0 mm slice thickness, 0.5 mm reconstruction interval, at 120 kVp, 150 effective mAs, at a pitch of 1.25, and with a 0.5 seconds gantry rotation time. All thin−section axial images were transferred to a workstation running a PC−based 3D reconstruction program(Rapidia 2.8 ; Infinitt, Seoul).

Fig. 3. CT scout shows contrast media extravasation(arrow) into the surrounded of the neck and thorax

Ⅲ. Results

Volume data were loaded into this program, and an experienced CT technologist performed the 3D reconstruction, which included axial images(Fig. 4), coronal(Fig. 5a) and sagittal(Fig. 5b) MPR, MIP(Fig. 6) and volume rendering(Fig. 7). Volume rendering was optimized for the reconstruction : opacity ; 100%, density range ; 28-1026(Fig. 7a). Volume−rendered obtained after eliminating the bone and muscle, shows the extravasation and IV catheter (arrow) opacity, 100%, density range ; 1149−2266 (Fig. 7b).

The neck and thorax were tensely swollen. The patient was closely monitored for the next 14 hours. Complete resorption of contrast media was visualized on the follow−up monitor 14 hour later(Fig. 8). Our institutional review board does not require approval or patient informed consent for CT scanning of previous obtained image data.



A B

Fig. 4. Transverse CT shows a large of contrast media of right neck and thorax. A, CT axial image of external jugular vein with resident IV Teflon catheter(arrow), demonstrating contrast media extravasation into the neck. B, Contrast media extravasated in the thorax area

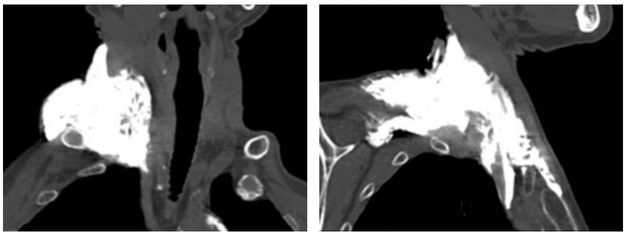


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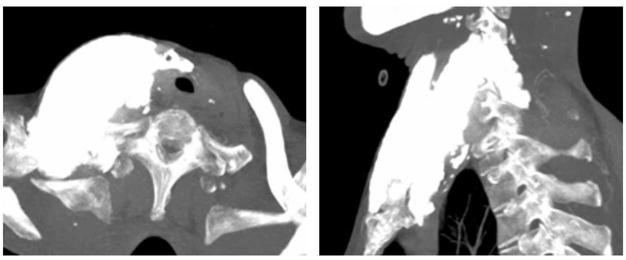
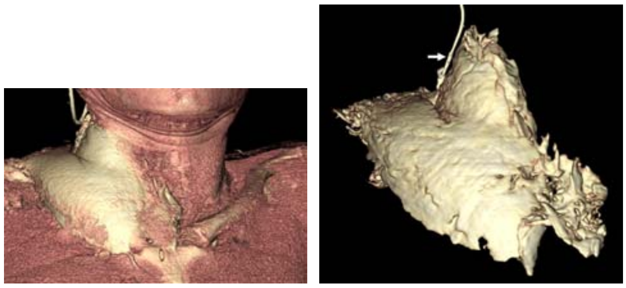
Fig. 5. Coronal(A) and sagittal(B) MPR image demonstrate the extravasation of contrast media into the right neck and thorax with profound radio-opacity



A B

Fig. 6. MIP display of the right neck of transverse(A) and anterior thorax of sagittal(B) showing the large volume of extravasated of contrast media



A B

Fig. 7. Volume rendering show the extravasation around the right neck and thorax. This image demonstrates extravasation of the intravenous catheter in the jugular vein. A, Volume rendering was optimized for this reconstruction : opacity ; 100%, density range ; 28-1026. B, Volume-rendered obtained after eliminating the bone and muscle, shows the extravasation and IV catheter (arrow) opacity, 100%, density range ; 1149-2266

Fig. 8. A 60-year-old man referred for lower extremity angiography CT examination was administered 120 mL of contrast media through an intravenous catheter place in the right external jugular vein. The image shows the right jugular vein approximately 14 hour after the extravasation had occurred

Ⅳ. Discussion

Extravasation injuries are usually caused by leakage around the original puncture site where the catheter enters the vein. Moreover, higher frequencies of extravasations have been encountered due to the routine use of power injectors for CT[5]. Traditionally, efforts to avoid extravasation have focused on prevention by exercising special care in high−risk groups[6−8].

Subcutaneous extravasation is a well−known complication of radiological examinations involving the intravenous injection of contrast media. Nonionic contrast agents are safer than high−osmolality agents, and in most patients, conservative treatment is successful in cases of small volumes of extravasation of nonionic agents[9,10].

Skin and soft−tissue necrosis are well recognized complications of the extravasation of high−osmolality contrast medias[2], and the higher risks of extravasation from the venous circulation during contrast−enhanced CT when using a power injector in cases of substantial skin necrosis[11], are well documented[12].

However, little documentation is available on the natural course of extravasated contrast media in the neck and mediastinum[13]. Ultrasonography−guided jugular vein catheter placement is a safe procedure with a high success rate and few associated complications[14]. In particular, moderate to large volumes of medium may be extravasated when power injectors are used[15].

3D visualization techniques are available for acquiring CT volume data, e.g., MPR, MIP and volume rendering. Volume rendering is excellent for depicting 3D images[16], and has advantages over two−dimensional axial views[17]. Moreover, the post−acquisition processing of volume rendered images was minimal. This technique is easily learned and optimized for each case. The software provided in many CT program packages allows additional color image enhancements, which might improve image quality. Moreover, five optimized techniques can be used to accurately measure the vessel diameters[16].

Extravasated contrast media can be observed in preoperative and/or postoperative radiographs of the affected extremity[18]. Three separate techniques have been used to enhance CT performance, i.e., axial, MPR, MIP, and volume rendering. MPR is useful for rapidly reviewing all information in coronal, sagittal or oblique views. A ray is projected along the data set in a user−selected direction and the highest voxel value along the ray becomes the pixel value of a two−dimensional MIP image. The resulting images are usually displayed with no surface shading or other devices to help the user appreciate the "depth" of the rendering, which makes 3D relationships difficult to assess. A volume data set is analyzed interactively using various display algorithms to select and weight voxels to achieve a display that highlights tissues and relationships of interest. Transfer functions are used to map properties, such as, opacity, brightness, color, and windowing to voxels in the volume of interest, and all voxels in the volume potentially contribute to the final image. In real−time, the displayed image can be cut and rotated, and transfer functions can be altered, though it follows that this requires more processing power. Volume rendering techniques sum the contributions of voxels along a line from the viewer's eye through the data set. This is done repeatedly to determine each pixel value in the displayed image.

Initially, thin−section axial images were reviewed in order to identify the extent of the contrast extravasation. Thereafter, volume rendering and MPR images were generated to better understand the anatomic relationships between veins, adjacent bones, and soft tissue. To our knowledge, this study is the first to demonstrate the use of 3D CT reconstruction for the evaluation of contrast extravasation.

The mechanism of extravasation in the presented case is unclear. The intravenous catheter well fitted the external jugular vein. However, an inspection after removing catheter revealed no evidence of mechanical damage that could have allowed a leak. This paper reports the 3D findings of contrast medium extravasation in the neck and thorax, and demonstrates that a complete evaluation of the contrast medium extravasation area is possible using all four 3D CT reconstruction settings.

V. Conclusion

The large majority of IV contrast extravasation injuries do not cause short or long term sequelae, and affected patients do well with conservative management. The described case supports the merit of conservative management even in extreme cases of extravasation into the neck and thorax. This study showed that a complete evaluation of the contrast material extravasation area is possible using all four 3D CT reconstruction settings. These 3D findings might also help to determine the best course of treatment for patient with contrast media extravasation.

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• 국문초록

CT검사에서 조영제의 혈관외유출에 의한 목 및 흉부 손상의 3차원 재구성 영상

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전산화단층촬영에서 조영제를 자동주입기로 주입하는 과정에서 발생하는 혈관외유출은 조직의 괴사 및 손상의 원인이 되고 있다. 대량의 혈관외유출은 구획증후군으로 발전하여 근막절개술을 시행하는 경우가 발생한다. 혈관외유출이 발생한 환자를 대상으로 혈관외유출 범위 및 부위 정도를 평가하기 위해 CT 검사에서 경정맥에 조영제을 주입하는 과정에서 혈관외유출이 발생한 환자를 대상으로 하였다. 조영제에 의한 혈관외유출 범위 및 손상을 확인하기 조영제 주입부위의 목 및 가슴의 부위를 MDCT를 이용하여 스캔하였다. 경정맥 주사부위의 혈관외유출부위를 MPR, MIP와 볼륨 렌더링의 3차원영상을 3D 프로그램을 이용하여 묘출하였다. 3차원 재구성 영상은 높은 해상력과 정확도를 제공하여 혈관외유출 범위 및 부위를 확인 하여, 환자의 예방의 필요성 및 사후 조치 및 적절한 치료와 수술 계획에 유용하게 이용될 것으로 기대된다.

중심 단어: 3차원 영상, 경정맥, 조영제, 혈관외유출, 전산화단층촬영