조영제 혈관외유출 현상의 3D MDCT 재구성 영상

3D MDCT Reformation Findings of the Radiographic Contrast Medium Extravasation

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요약

전산화단층촬영에서 자동주입기에 의한 방사선 조영제의 혈관외유출(140mL)이 우측 손등의 IV 카테터 부위에서 발생하였다. 혈관외유출은 부종 및 괴사를 동반하였고, 구획증후군으로 발전하였다. 혈관외유출 부위를 MDCT로 스캔하여, 3D 재구성 영상인 MPR, MIP, volume rendering으로 재구성하였다. 이러한 3D 재구성 영상은 조영제의 혈관외유출 부위를 침범 정도를 정확하게 확인하여 환자 예방의 필요성 및 사후 조치에 적절한 치료 및 수술 계획에 유용하게 이용될 수 있다.

■ 중심어 : | 조영제 | 혈관외유출 | 3차원 영상 | 전산화단층촬영 |

Abstract

Radiogrpahic contrast medium may cause tissue injury by extravasation during intravenous automated injection during CT examination. A large - volume extravasation (140 mL) occurred in an adult during contrast-enhanced CT. The patient had a swelling and injury on the dorsum right hand of intravenous catheter region. The extravasation injury site was determined by CT scanning. The extavasation compartment syndrome case was examined using four separate display techniques. These 3D MDCT findings might help to determine the best course of treatment for patient with contrast extravasation. 3D image reconstructions provide accurate views of high-resolution and soft-tissue imaging. This paper introduces extravasation with the radiography and 3D MDCT findings.

■ keyword : | Contrast Medium | Extravasation | 3D | Computed Tomography |

I. Introduction

The administration of contrast medium for multi-detector row computed tomographic(MDCT) is typically accomplished by a power injector in the gantry room during scanning. The extravasation of intravenously injected contrast medium is a well-recognized complication of radiological examinations. Extravasation is defined as the leakage of the solutions from the vein. The extravasation of water-soluble contrast medium can sometimes cause

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tissue necrosis and compartment syndrome. Tissue damage from the extravasated contrast medium is caused by the direct toxic effect of the agent. Compartment syndrome may also occur if a sufficient amount of contrast medium leaks into the surrounding skin and subcutaneous tissues [1]. Skin necrosis after the extravasation of contrast medium is a potential complication when mechanical power injectors are use to inject large volume of contrast at a high flow rates.

This study presents a case of compartment syndrome of the hand immediumtely following extravasation of an intravenous injection of CT contrast medium into the dorsum of the right hand. The CT studies of the extravasation case site were performed using a three dimensional (3D) software program with four different display techniques. This paper presents another intravenous catheter injection extravasation along with the 3D MDCT findings in a patient who underwent enhanced CT examination.

We study our initial experience with the routine use of CT scanning for extravasation injury assessment in cases of complex swelling dorsal hand reconstruction. This study showed that a complete evaluation of the contrast medium extravasation area is possible using all four techniques. In order to prevent serious extravasation accidents of contrast medium, medical personnel need to be aware of the seriousness of the extravasation compartment syndrome.

II. Subjects and Methods

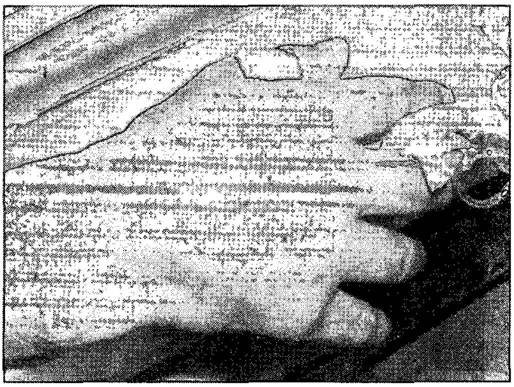
1. Patient selection

In this study, a 76-year-old man was referred to our service for lower extremity CT angiography of his leg because of suspected arteriosclerosis. Contrast enhancement was thought to be indicated, and briefly, an 18-gauge Teflon IV catheter (BD IV Catheter; Becton Dickinson Korea, Seoul, Korea), was inserted into a dorsal venous network of the right hand by a registered nurse.

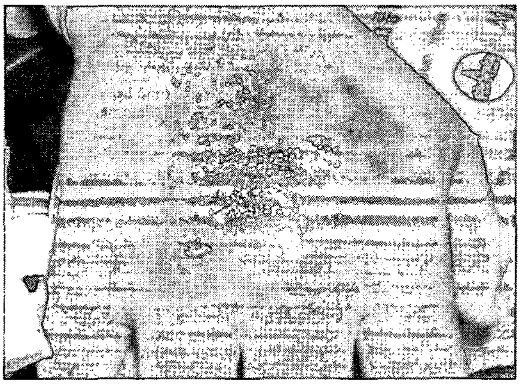
2. CT Technique

Non-ionic iopromide contrast medium (Ultravist 370; Schering, Berlin, Germany) was administered at a rate of 3.0 mL/sec, and a pressure of 221 psi using a mechanical injector (Empower CTA EZEM, Westbury, NY). The extravasation detection accessory (EDA) had not adhesive-backed electrode patch that was placed on the patient's dorsal hand of IV catheter. A Smart-Prep bolus tracking system acquisition was performed at a stationary level in the abdominal aorta of the scan volume with 10 mm section thickness, one image every 2.5 seconds for a total of 40 seconds. Time to peak enhancement at this level (HU; 50) was determined by region-of-interest analysis, and contrast medium elapsed time of 31 seconds.

The patient made no complaint during the course of the CT examination, but after the scanning, the technologist noticed visual evidence of extravasation of contrast medium. Patient had extravasation of approximately 140 mL of contrast medium into the dorsum of the right hand during a CT examination [Fig. 1A]. The supervising radiologist was notified immediately. An orthopaedic surgeon service was consulted to evaluate the large extravasation [1].



(A)



(B)

Figure 1. Large volume extravasation of radiographic contrast medium. Case of a 76-year-old man referred for the lower extremity angiography CT examination who was inserted with 140 mL of contrast medium through an intravenous catheter place in the dorsum of the right hand. Clinical photographs showing diffuse soft-tissue swelling was noted extending in the dorsum of the right hand (A). Approximately seven hours after the extravasation occurred (B). The hand and the distal part of the forearm were tensely swollen. The progressive signs and symptoms and the ultimate development of an acute compartmental syndromes 14 hours after extravasation fit well with the hypothesis that the agent was injected subfascially.

The extravasation injury area was imaged with an eight-detector row CT scanner (LightSpeed Ultra, GE Medical Systems, Milwaukee, WI), the parameters were 8 × 1.25 mm detector collimation, 1.3:1 pitch (17.5 mm table speed/rotation), 1.25 mm slice thickness, 1.25 mm reconstruction interval, at 120 kVp, 100 mA, and a 0.5 seconds gantry rotation time. An initial scout image was obtained to determine the scan volume.

Ⅲ. Results

CT axial images [Fig. 2] were transferred to a workstation installed with PC-based 3D reconstruction software (Rapidia; Infinitt, Seoul, Korea). The volume data were loaded into the 3D program, and an experienced CT technologist performed the 3D reconstruction, which included MPR [Fig. 3], MIP [Fig. 4], and volume rendering [Fig. 5]. MPR and axial images, measurements from one inside vessel wall and contrast edge to the opposite inside wall and contrast edge were obtained. For the axial and MIP images, the display window and level were optimized for this particular contrast density. Volume rendering was optimized for the reconstruction: opacity; 100%, HU threshold range; 150-1480.

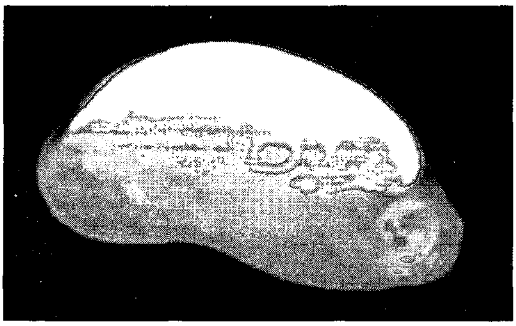
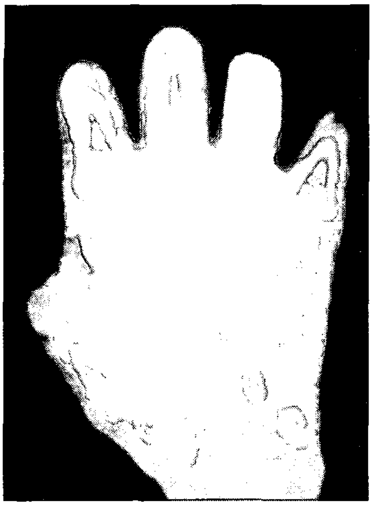


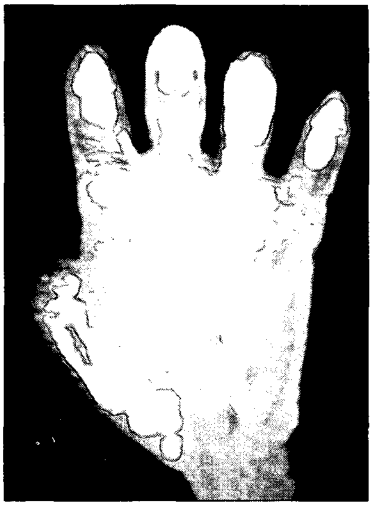
Figure 2. Transverse CT shows large amount of contrast medium in the dorsum of the right hand.



(A)

(B)

Figure 3. Coronal MPR dorsal deep (A) and surface (B) images demonstrate the extravasation of contrast medium.



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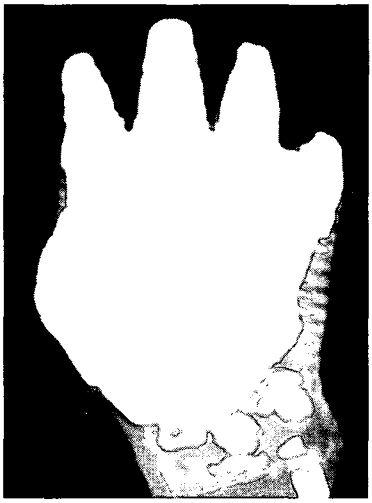


(B)

Figure 4. MIP images deep (A) and surface (B) of the dorsum of the right hand. Coronal image demonstrates the extravasation

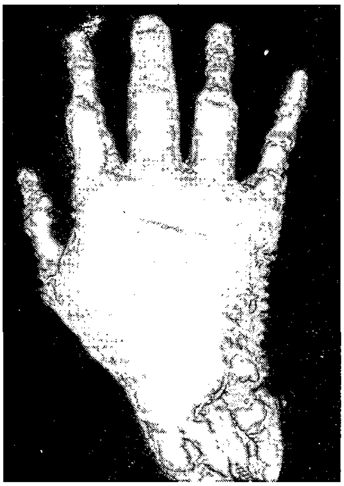
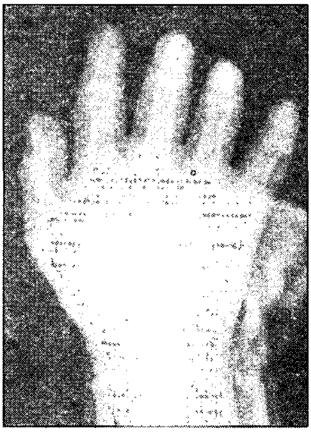


Figure 5. 3D volume rendering CT scan images of the right hand. Image demonstrates the extravasation.

CT scanning after the involved hand was elevated, and cold compresses were applied to the site[2]. The patient was closely monitored for the next seven hour [Fig. 1B], and serial measurements showed increases in the girth of the forearm compared with the uninvolved hand. The patient subsequently began to have decreased sensorimotor function and a feeling of severe tightness within the hand. Approximately fourteen hour after the extravasation occurred, hand pain became increased, and the patient's radial and ulnar pulses were difficult to palpate. The hand and the distal part of the forearm were tensely swollen. The consultant thought that the patient was experiencing an acute compartmental syndrome related to the extravasation. The patient was taken to the operating room immediately for management of the hand and wrist compartment syndrome, and emergent fasciotomy was performed. The patient's postoperative course was unremarkable since then. Preoperative radiograph taken in case show the extent of this massive extravasation of contrast medium [Fig. 6A]. There is so much contrast medium in the dorsal soft tissues. Post-operative radiograph show nearly complete drainage of contrast medium after fasciotomy [Fig. 6B]. He further recovered from his injuries and had returned to patient's ward.



(A)

(B)

Figure 6. Preoperative radiograph (A) taken in case show the extent of this massive extravasation of contrast medium. There is so much contrast medium in the dorsal soft tissues. Postoperative radiograph (B) shows nearly complete drainage of contrast medium after fasciotomy.

Our institutional review board does not require approval or patient informed consent for CT scanning of previous obtained image data.

Ⅳ. Discussion

Extravasation injuries are usually caused by leakage around the original puncture site where the catheter enters the vein. Extravasation of contrast medium also has been printed with respect to producing local tissue necrosis[2]. Higher frequencies of extravasations have been encountered since routine use of a mechanical power injection of contrast medium for CT was introduced[3]. Traditionally, efforts to avoid extravasation have focused on prevention by exercising special care in high-risk groups[4].

Subcutaneous extravasation is a well-known complication of a radiological examination involving an intravenous injection of contrast medium. Nonionic contrast agents are safer than high-osmolality agents, and in most patients, conservative treatment is successful for the extravasation of small volumes of nonionic agents[5].

Compartment syndrome is a symptom complex resulting from increased tissue pressure within a limited space that compromises the circulation and function of the contents of that space. Compartment syndrome results in intrinsic muscular dysfunction and loss of hand function[6]. Compartment syndrome of radiographic contrast medium has been printed[7]. The higher risk of extravasation from the venous circulation during contrast-enhanced CT when administered using a power injector with cases of substantial skin necrosis[8].

Caution should be exercised in the management of all cases of extravasation of contrast medium, especially with moderate to large volumes of medium that may be extravasated when mechanical auto injectors are used.

The exquisite an anatomical detail of spiral computed tomographic scanning coupled with its ability to show abnormalities adds a dimension of detail. 3D visualization techniques are available for acquiring the CT volume data, such as MPR, MIP, and volume rendering. Volume rendering is excellent for in depicting 3D images[9], and has advantages over two-dimensional axial views[10].

There is minimal post-acquisition processing for the volume rendering images was minimal. This technique is easily learned and easily optimized for each case. The software provided on many CT software program allows additional image enhancement with the use color, which might improve the image quality. Five optimized techniques can be used to accurately measure the vessel diameters[9].

The extravasated contrast medium can be observed in the preoperative and/or postoperative films plain radiographs of the affected extremity[11], and in the body topogram obtained for abdominal CT[7]. Four separate techniques have been used in the in the performance of CT: axial (cross sectional), MPR, MIP, and volume rendering. MPR is useful for rapidly reviewing all the information in coronal MPR dorsal deep [Fig. 3A] and surface image [Fig. 3B]. 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, making 3D relationships difficult to assess. Therefore, MIPs in more than one direction may be needed to evaluate a data set [Fig. 4A][Fig. 4B]. 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 the voxels in the volume of interest, with all voxels in the volume potentially contributing to the final image. In real-time, the displayed image can be cut and rotated, and transfer functions can be altered. It follows that this needs more powerful processing computers. Volume rendering technique sum the contributions of each voxel 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. Volume rendering algorithms are capable of revealing internal structures that would normally be hidden when using traditional surface rendering techniques [Fig. 5].

Initially, the thin-section axial images were reviewed, in order to identify the extent of the extravasation of contrast medium. Thereafter, volume rendering and MPR images were generated to allow a better understanding of the anatomic relationships between the veins and adjacent bones, and soft tissue. To our knowledge, this study is the first to demonstrate the use of a 3D CT reconstruction in an evaluation of contrast medium extravasation. When compared with radiography, CT has many advantages over radiography. It demonstrates more anatomical detail, soft tissue, and extravasation area.

Although the EDA cannot be used of patient that power injection of contrast medium is used, its use in appropriate clinical situations should reduce of extravasation. More significantly, it will improve patient safety[5][12].

V. Conclusions

In, conclusion, we evaluated a 3D MDCT reformation findings of the contrast medium extravasation in the dorsum hand. This study showed that a complete evaluation of the contrast medium extravasation area is possible using all four 3D CT reconstruction settings. These 3D findings might help to determine the best course of treatment for patient with contrast extravasation.

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