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(a) Title

Simple, frequent indicator for personal identification — post-mortem and ante-mortem abdominal computed tomography findings of a charred body

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Title

Simple, frequent indicator for personal identification — post-mortem and ante-mortem abdominal computed tomography findings of a charred body

Abstract

Post-mortem personal identification in forensic science is performed using various methods. However, severely burnt bodies are hard to identify using odontological or skeletal features due to carbonization, and sometimes DNA profiling is impracticable due to the unavailability of the relatives. We present a case of a burn victim found after a house fire. Personal identification was attempted, but the body was heavily charred to the bones and the use of physical appearance was impracticable. There were no known relatives or personal belongings of the deceased for comparison of DNA typing. We obtained a series of abdominal computed tomography (CT) scans taken ante-mortem and found bilateral multiple renal cysts, left renal artery calcification, and a big right inguinal hernia which matched the deceased's post-mortem CT findings and autopsy findings. To date, studies of identification by CT have acted for a rise in precision, but they require complicated calculation or high graphical methods. Calcification of the arteries or renal cysts seen in our case are very common lesions present in many adults with abundant variation, thus they may be helpful as simple indicators for identification.

Keywords

Identification, post-mortem imaging, computed tomography, burnt body, internal organs

Introduction

Identification of the dead is an important issue in forensic science. Comparison of fingerprints, DNA typing for comparison with samples from family members or personal items of the deceased, and odontological features are generally accepted as reliable methods for post-mortem identification.[1] DNA profiling has been reported to be an excellent tool for identification of fire victims. Meyer reported successful identification of all 155 victims of the November 2000 Kaprun cable car fire disaster by matching DNA types to the victims' ante-mortem belongings or relatives.[2] In addition, Clayton et al. reported the identification of 26 body fragments by comparison with relatives using DNA samples from 61 body fragments in the April 1993 Wako fire disaster.[3] Teeth, along with their restorative materials, can withstand temperatures of up to 600°C,[4] and in the case of a house fire that resulted in the death of a father and son, a combination of dental examination and DNA profiling led to successful identification.[5] However, these tools are not practicable when there is no relative for DNA typing[3] or when the victim's dental records are unavailable.[5]

Computed tomography (CT) is a widely used imaging modality in clinical examination. Japan is said to have the largest number of CT scanners per capita[6] and CT images are often readily obtainable as ante-mortem medical records; Therefore, post-mortem CT images have also been used in personal identification. To date, bone imaging using CT to evaluate thoracic shape, paranasal sinus structure, or vertebral features has been studied as a tool for personal identification.[7-10] Thus, identification by CT is generally recommended to use hard tissues due to their preservation, but in cases of deaths from fire, especially heavily charred bodies, facial and thoracic bones are often destroyed and such methods are impracticable for personal identification. Additionally, although the accuracy of two- or three-dimensional CT comparison is discussed in several reports,[10-12] they require high graphical methods and complicated calculation. Unfortunately, very few forensic institutions have well-trained forensic radiologist or radiological technician. In case of mass disaster, a disaster victim identification team including such experts may organized; however, a single forensic pathologist has to owe the identification of the body in daily autopsies. Therefore, simple method is required.

Here, we report a case of a body found at a fire scene. The external surface was heavily charred and the bones were destroyed. The suspected victim had no known relatives, making it difficult to identify the individual by DNA profiling or odontological methods. However, post-mortem CT revealed some characteristic findings in the remaining abdominal organs that matched those in the suspected victim’s ante-mortem CT findings and autopsy findings, and thus helped to identify the victim.

Materials and Methods

One night in winter, fire was noticed emanating from an apartment. About 50 min after the fire dispatch, firefighters found a severely burnt body lying in the supine position in a room.

A 62-year-old man with no known blood relatives had lived alone in the apartment for 19 years but he could not be reached after the fire. The man had admitted to the emergency department due to syncope a month before the fire, but he had no other known medical history or routine medications.

Forensic examination and autopsy were performed to determine the cause of death and identify the victim.

Results

1. Radiological investigation

Post-mortem CT was performed using the Supria® scanner (Hitachi Medical Corporation, Tokyo, Japan) with scan parameters of 120 kV, 250 mA, and 1.25 mm slice thickness. Abdominal CT revealed multiple renal cysts in both kidneys with calcification of the abdominal aorta, celiac artery and left renal artery (Fig. 1).

2. Autopsy findings

Autopsy was performed the day after the body was found. The body was heavily charred and the bones of the skull, face, and extremities had been destroyed. The right thorax and the right upper abdominal wall were completely burned, exposing the lungs, mediastinum, liver, and intestines, the surfaces of which were all carbonized.

A fist-sized mass of fat tissue with intestine-like contents was observed in the right inguinal region apart from the bowel extruded from the left abdominal wall (Fig. 2), in addition to multiple bilateral renal cysts. The pharyngeal mucosa and epiglottis were severely edematous and soot was observed in the trunk, bronchi, esophagus, and stomach.

3. Chemical and toxicological analysis

Carboxyhemoglobin concentrations in the left cardiac blood, right cardiac blood, and femoral venous blood measured by colorimetric assay were 41%, 30%, and 34%, respectively. Blood ethanol concentration measured using gas chromatography was 1.3 mg/mL. Toxicological screening analysis performed using ultra-performance liquid chromatography (Acquity UPLC/Xevo™ G2—S QTof; Nihon Waters K.K., Tokyo, Japan) detected caffeine and bisoprolol.

The cause of death was determined as effects of fire based on the soot in the airway and upper gastrointestinal tract, high carboxyhemoglobin concentrations, and the absence of evidence of other severe organic disease.

4. Personal identification

According to the Interpol disaster victim identification guide (2010), dental and medical records, fingerprints, and DNA are the recommended ante-mortem data to be collected.[13] In this case, however, the use of physical appearance was impracticable because heavy carbonization had distorted the external features, and odontological examination was also not possible. Therefore, we gathered the victim's ante-mortem medical data and compared the findings then with post-mortem CT images and autopsy findings.

In the process of collecting the ante-mortem medical data, we noticed that he had previously undergone head and abdominal CT during a 1-night hospitalization due to syncope. We obtained abdominal images of the contrast CT taken at the hospital at 120 kV, 531 mA and compared them with the pre-autopsy full-body CT images of the corpse. Abdominal axial images from ante-mortem CT revealed bilateral renal cysts (Fig. 3) and the localization and size matched with those in the post-mortem CT and autopsy findings of the corpse. They also showed a characteristic calcification in the left renal artery (Fig. 3), which was similar to that in the post-mortem CT. Ante-mortem pelvic axial images revealed a right inguinal hernia containing intestine (Fig. 4), which corresponded to the fist-sized mass in the corpse's right inguinal region.

DNA analysis was to be carried out by the Scientific Criminal Investigation Team of Kyoto Prefectural Police Headquarters, however, the victim had no known relatives form whom reference DNA samples could be obtained and all his personal belongings had been destroyed in the house fire. DNA samples were eventually collected from disposable chopsticks found at the man's workplace.

The DNA type matched that of the corpse, but the results were only partly reliable because disposable chopsticks are widely used and available.

Finally, the combination of matched CT findings and DNA profiling results led to the conclusive identification of the corpse cadaver as the missing resident.

Discussion

Our report presents a case where information of the soft tissue from CT images was helpful for personal identification. The highlights of this case are as follows: First, although the body was severely damaged by fire, the retroperitoneal organs were still intact enough to contribute to personal identification. Next, the CT findings used to identify the body were features of commonly occurring disease conditions.

The comparison of ante-mortem and post-mortem CT images has been studied using skeletal features. Matsunobu et al. reported successful identification by comparing two-dimensional and three-dimensional thoracic bone images constructed using CT.[7] Also, Souza et al. and Heimer et al. reported cases in which comparison of the paranasal sinuses using CT and magnetic resonance imaging, respectively, were helpful.[8,9] However, it is reported that exposure to fires with temperatures of up to 670 - 810°C for more than 20 min destroys the facial bones and more than 30 min exposure distorts the thoracic cavity.[14] As the temperature in a house fire reaches 650 –870°C,[15] the bones of the extremities, skull, or thorax are often destroyed and cannot be used for identification. On the other hand, even in heavily charred bodies, retroperitoneal organs may retain their shape due to their high water content.[15]

Previously, several cases had been reported where bodies were identified using past medical records. Beggan et al. reported identification of a charred remains where the victim had a very rare abnormality of the spinal canal known as diastematomyelia.[16] Others report that the use of the serial number of an implanted device such as an artificial joint or intrathecal medication pump.[17,18] Although these specific deformities or unique artificial devices are highly useful in identification, such cases are infrequent. On the other hand, renal cysts or inguinal hernias as observed in our case are more common.

Simple renal cysts are reported to be present in 19.7–49% of healthy individuals over 60 years of age,[19] but the increase in size is rather slow especially in the elderly. Therefore, they tend to be left without follow up or treatment.[20] This fact suggests that post-mortem images would show the renal cysts at almost the same position, shape, and size as the ante-mortem images, even if the ante-mortem images had been taken several years prior. Certainly, variations of location or size of renal cysts remain unknown, as is the precision in terms of personal identification. In our case, direct comparison of the images by the superimposition method, for example, was not used because body structure and organs are distorted or shrunken in severely burnt cases.

Inguinal hernia is said to develop in 27% of men during their lifetime.[21] While variations are minimal[21] unlike renal cysts, in some cases surgery is suspended after medical personnel notice the lesion,[22] just as in the present case. In such cases, the lesion may be of help for identification when the clinical features match the medical records.

Identification should be determined by using a combination of multiple methods[23] and comparison of ante-mortem and post-mortem images is one of these options. Our case demonstrates that not only rare or unique features but also common lesions can contribute to identification. Renal cysts and calcification of the arteries are so common that we tend to consider them ‘normal’ and do not take them important, but in case of personal identification such common lesions can be useful. It is important to recognize that such common lesions are not always considered clinically significant and are often omitted from written records. Therefore, comparison of the images themselves is essential.

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Figure Legends

Fig. 1 Abdominal post-mortem axial CT image. Acquisition conditions were 120 kV, 250 mA, and 1.25 mm slice thickness. Reading conditions were window level 60, window width 300. Bilateral renal cysts (arrows) and left renal artery calcification (triangle) are shown.

Fig. 2 Fist-sized mass of fat tissue with intestine-like content exists in the right inguinal region (arrow), apart from the bowel extruded from the left abdominal wall (triangles).

Fig. 3 Abdominal ante-mortem axial CT image. Acquisition conditions were 120 kV, 531 mA. Reading conditions were window level 60, window width 300. Estimated to be contrast CT, though precise condition information in unavailable. Bilateral renal cysts (arrows) and left renal artery calcification (triangle) are shown, as in Fig 1.

Fig. 4 Pelvic ante-mortem axial CT image. Acquisition conditions were 120 kV, 531 mA. Reading conditions were window level 60, window width 300. A right inguinal hernia containing intestine is shown (arrows).

Figure 1

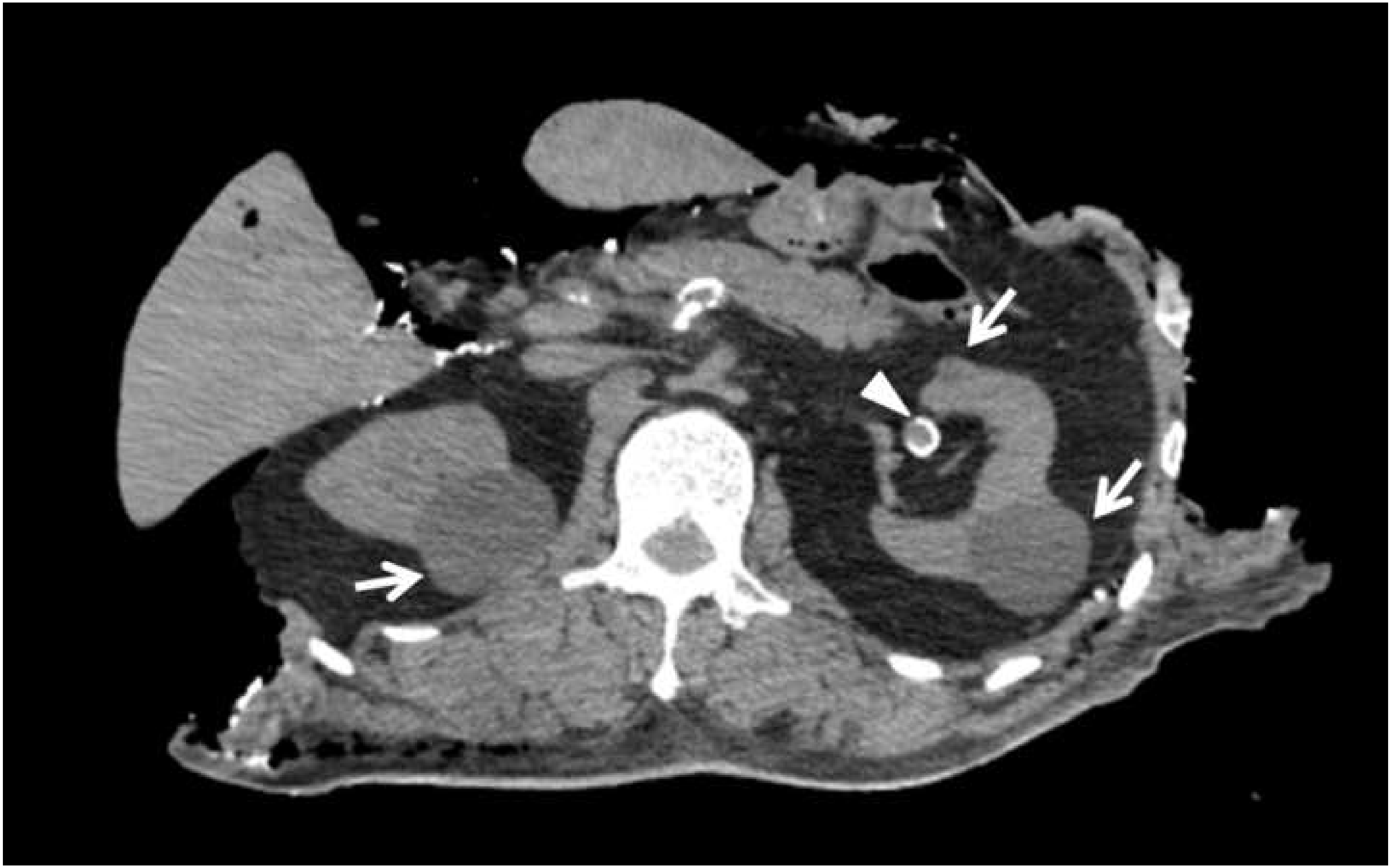

Figure 2

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Figure 3

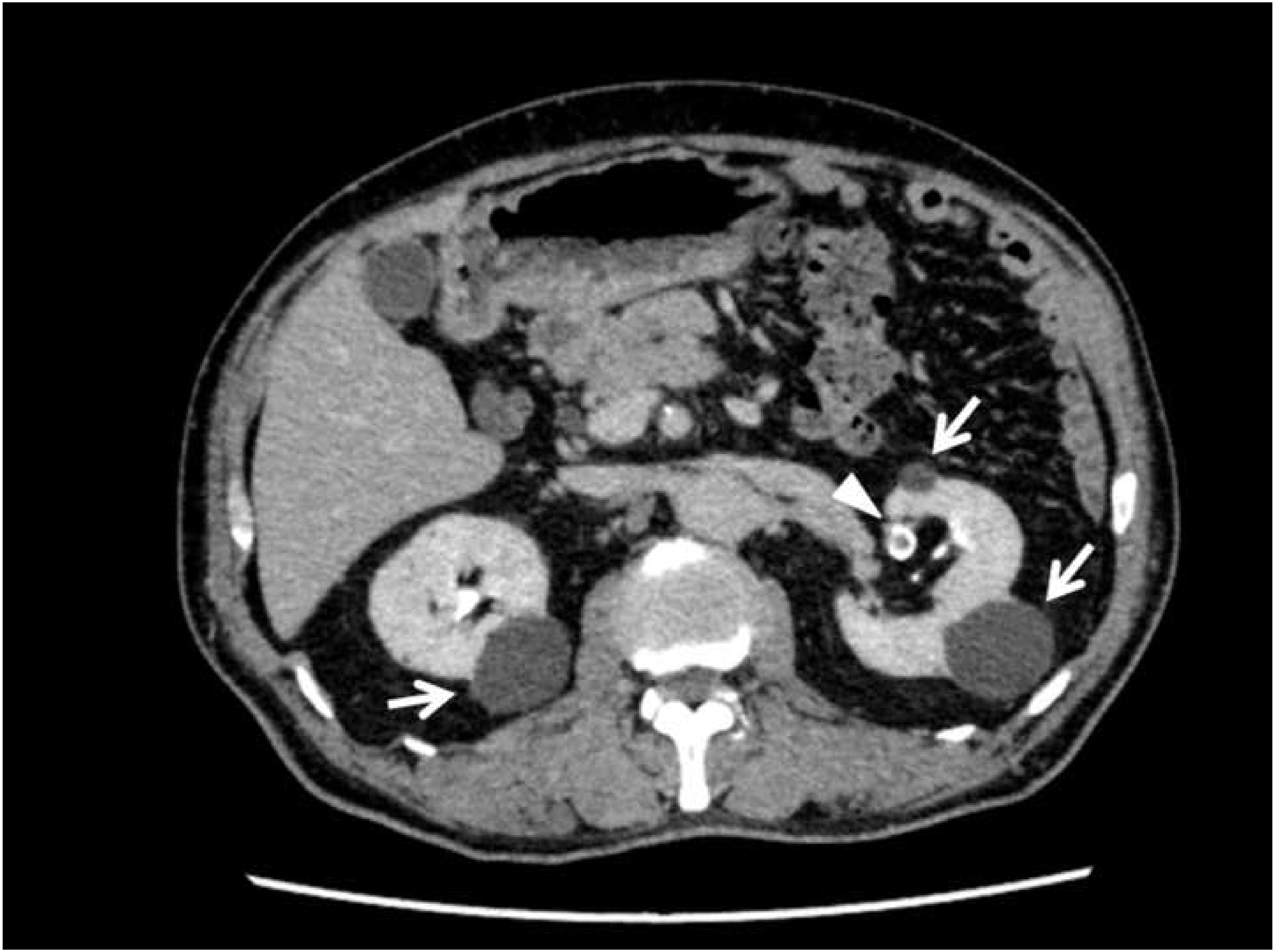

Figure 4

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