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Impressive Images of Gall Stone and Renal Stone by Radiologically Reconstruction Method

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Abstract

Background: Recently, diagnostic imaging technology and Deep Learning Image Reconstruction (DLIR) have been in focus. Authors have continued clinical practice and research for DLIR.
Case presentation: The patient is 68-year-old men with type 2 diabetes (T2D).
Results: DLIR of abdominal CT showed gallstones in the gall bladder and renal stones in left kidney. The detail condition was apparent found by transverse, coronal and sagittal three views. Furthermore, impressive images were obtained from bone and visceral conditions of DLIR.
Discussion and Conclusion: DLIR will become more beneficial and indispensable strategy for actual medical practice, diagnosis and treatment in the future.

Keywords: Deep Learning Image Reconstruction (DLIR); Diagnostic Imaging Technology; Synapse Vincent; Low-Dose Computed Tomography (LDCT); Deep Learning Trained Algorithm (DELTA)

Introduction

Recently, deep learning reconstruction for CT images has been evolving [1]. For better CT images, more detailed structures have been revealed. The radiological dose has been lower levels. Thus, investigation on the Deep Learning Image Reconstruction (DLIR) algorithm have progressed [2]. Furthermore, research on its technical aspects has been in progress. For evaluating the effect of commercial DLIR algorithm on the image quality of chest CT, exams for upper abdomen were in focus [3]. As a result, DLIR chest CT revealed comparable DLIR quality for the area of upper abdomen, in the case of less than 50% of radiation dose. For recent study, sinogram-based DLIR would become an impressive method. Its characteristics showed improved quality of image and lower presence of noise [4]. This way may lead to reduction of radiation dose in future clinical routine.

The authors and co-researchers have continued clinical research for years [5]. For the medical area, broad fields are included such as, type 2 diabetes (T2D), chronic kidney disease (CKD), cardiovascular disease (CVD) and so on [6,7,8]. Further, our clinical team have reported several radiological case reports such as early stage detection of diseases and computed tomography (CT) using reconstruction analyses [9-11].

These radiological analysis techniques have been recently developed. In our actual clinical practice, we have experienced an impressive case. The case had both of gallstones and renal stones, where CT reconstruction method showed detail results. In this article, the general information and perspectives would be described.

Case Presentation

History and Physicals

The patient is a 68-year-old male patient with hypertension, Type 2 diabetes (T2D), obesity, and renal stone. He was treated for these diseases for 5 years. In 2020, he was pointed out to have renal stone in the left kidney. During 2021 and 2022, his HbA1c was rather stable. Regarding his physical examination on May 2022, his height and weight showed 170 cm and 83.9 kg with 29.0 kg/m^2 of body mass index (BMI). The consciousness, speech, vitals and neurological findings revealed no remarkable findings. His lung, heart, abdomen and orthopedic problems are unremarkable.

Several Exams and Problems

Several biochemical tests were performed in May 2022. The results were in the following. They are AST 19 U/L, ALT 20 U/L, GGT 14 U/L (< 86), LDL 98 mg/dL, TG 59 mg/dL, HDL 48 mg/dL, BUN 15 mg/dL, Cr 0.96 mg/dL, uric acid 7.1 mg/dL, eGFR 59.0 mL/min/1.73m^2, WBC 5000 /μL, RBC 5.04 x 10^6 /μL, Hb 14.2 g/dL, Ht 44.2%, Plt 18.2 x 10^4 /μL. As basic other tests for recent half year, chest X-ray was unremarkable, and ECG was within normal limits.

According to his medical problems for some years, the main problem-oriented system showed the following: i) T2D, HbA1c was 6.2 – 6.4% during last 5 months, ii) hypertension: his blood pressure (BP) has been stable, iii) hyperuricemia: uric acid values were 7.1-7.3 mg/dL for 1 year, iv) chronic kidney disease (CKD): his eGFR is calculated as 59 mL/min/1.73 m^2, v) obesity: high BMI has been persisted for years. His body weight has shown seasonal changes, in which around 89kg during winter and around 85kg during summer. His medication has been stable for years as metformin 500mg, teneligliptin hydrobromide hydrate 20mg, valsartan 80mg and amlodipine besilate 5mg.

Results

The patient has previous history of gallstone and renal stone about 2 years ago. Then, he received abdominal CT scan in May 2022. Transverse plain of CT showed plural gall stones in the gall bladder (Figure 1a,1b).

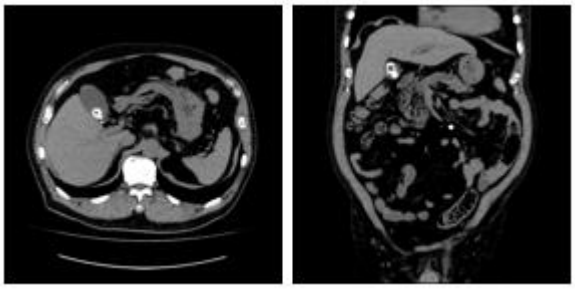

Figure 1: *Abdominal CT showing gall stone in the gall bladder*

1a: Transverse view of abdominal CT (red arrow)

1b: Coronal view of abdominal CT (red arrow)

Further, it showed renal stone in the left kidney (Figure 2a,2b).

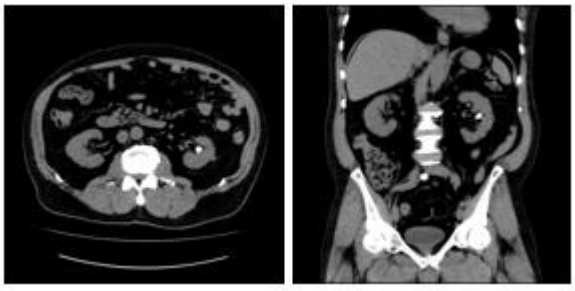

Figure 2: *Abdominal CT showing renal stone in the left kidney*

2a: Transverse view of abdominal CT (yellow arrow).

2b: Coronal view of abdominal CT (yellow arrow).

From these fundamental data of this CT scan, reconstruction analysis method was conducted for detail image. As a result, coronal image of abdomen was made, which indicates gallstones (Figure 3a,3b).

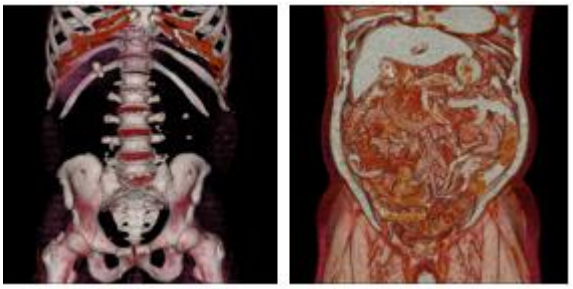

Figure 3*: Reconstruction results of abdomen by coronal view*

3a: bone condition: galls stone (blue) and renal stone (green)

3b: visceral condition: galls stone (blue)

In detail, fig 3a showed the predominance image of bone and elastic bone, and fig 3b showed the predominance image of visceral organs including liver, small intestine and colon. Sagittal plain analysis of the reconstruction method was performed (Figure 4a,4b).

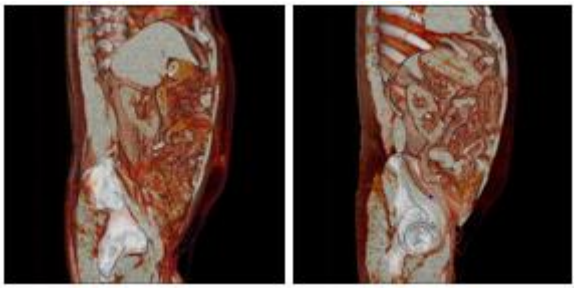

Figure 4: *Reconstruction results of abdomen by sagittal view*

3a: visceral condition: galls stone (blue arrow)

3b: visceral condition: renal stone (green arrow)

For this analysis, fig 4a showed the details of gall stones including the axis of right abdomen, and fig 4b showed the renal stones including the axis of left abdomen.

Ethical Considerations

This study was fundamentally conducted with the ethics principle. It includes the Declaration of Helsinki, and also the commentary from Ethical Guideline from the Research for Human aspect. These perspectives have been along with the content of Good Clinical Practice (GCP). Authors et al. established the ethical committee in the hospital for discussion of ethical matters. The committee exists in Kanaiso Hospital including some professional members. They are the president of the hospital, physician, nurse, pharmacist, dietitian and legal specialty. For the meeting of the committee, we had enough discussion about this issue. The result showed that agreements were obtained for this investigation. The informed consent was taken for written agreement from the case.

Discussion

Recently, great strides have observed for diagnostic imaging technology. Among them, "SYNAPSE VINCENT" is one of the

excellent computer software which can draw high-precision three-dimension images from MRI and CT [12]. It can continue to develop technical analysis for several organs of human body. The present version has been equipped with deep learning automatic intelligence (AI). This high technology started in Japan for analysis of heart and liver functions in 2008. Successively, its application fields were expanded including head, respiratory/urinary organs, and orthopedic area. It can extract beneficial imaging for digestive, pancreatic, hepatobiliary and renal fields [13-15]. As regards to the diagnosis, manual operation associated with experience and skill was conducted formerly. However, AI technology has been recently used for applicable segmentation for leading to smooth diagnosis.

In this case report, the patient had gallstones and kidney stones. During clinical course, their details were clarified by the reconstruction of CT. Several perspectives of both aspects of gallstones and kidney stones would be described for this order.

Firstly, detailed diagnosis of gallstones has been important in clinical practice [16]. The reason is the possibility of mechanical intestinal obstruction due to gallstones, mainly in the elderly and frail patients. Generally, the abdominal X-ray examination and/or ultrasonography were limited and insufficient for diagnosing the cause of intestinal obstruction. On the other hand, the sensitivity for diagnosis becomes higher by performing abdominal CT and performing reconstruction from the data. This method would be the optimal modality for diagnosing the disease and complication. Further information would be crucial for detail situation of gallstones associated with the estimation of the number, size, location, and location of ileus [16]. For recent study for CT reconstruction, diagnostic qualities of image for liver were investigated [17]. The protocol included 207 cases of adults, 2 groups of standard-dose CT (SDCT) and low-dose computed tomography (LDCT), and 2 methods of hybrid iterative reconstruction (HIR) and DEep Learning Trained Algorithm (DELTA). As a result, LDCT applied the procedure of DELTA showed 49 % X-ray dose reduction in comparison with SDCT applied of HIR, in which the image quality was maintained.

Secondly, recent study concerning renal stones was found concerning DLIR algorithms. The comparisons of DLIR to standard reconstruction method for renal stones for young adults by unenhanced CT scan [18]. The results included 14 cases with totally 84 reconstruction data, and urolithiasis for 7 cases. Furthermore, the presence of urinary stones showed almost perfect degree (k=0.71-1.0) for DLIR algorithms. Many patients with urinary stone have radiation overexposure by abdominal CT. Then, image reconstruction of CT would be required. As to DLIR evaluation for CT, the detection of urolithiasis was investigated using low-dose non-enhanced abdominal CT [19]. For data analysis, three reconstructions were compared, including hybrid iterative reconstruction (HIR), filtered back projection (FBP) and DLIR. The results for LD abdominal CT showed DLIR showed superiority of image quality to HIR and FBP, in addition to excellent detection of urinary tract stones. For diagnosis of urolithiasis, CT can provide crucial information for the location, number and size of the stones. Among them, stone size would become an important marker for treatment decision. In recent study, reference sizes of 47 renal stones were measured by digital caliper [20]. Simultaneously, these stones were scanned by a low dose method using HIR and model-based iterative reconstruction algorithms (MBIR). As a result, CT measurements by multiplanar reformatations using bone window were evaluated for precise data. Some limitations are present in this report. This case had gallstones and renal stones, and was not in acute distress such as acute abdomen. Then, DLIR was performed for stable condition. If the patient should have acute pain, and could not hold the breath for CT scan, medical staff would consider adequate strategy for diagnostic procedure.

In summary, this report described a case with gallstones and renal stones and related perspectives for DLIR. In this research field, further research development would be expected for imaging analysis with ICT in the future.

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