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A Case with Detailed Renal Study by the Three-Dimensional Computed Tomography (3D-CT) Reconstruction

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Abstract

Authors have been involved in the reconstruction procedure of three-dimensional computed tomography (3D-CT) by Synapse Vincent based on Artificial Intelligence (AI). The patient was a 62-year-old male, and 3D-CT images showed renal cysts and stones. His clinical problems included high blood pressure, cholelithiasis, alcohol consumption, obesity, liver dysfunction, renal cyst, renal stones, and left renal ureteral obstruction. As the transparent image of 3D-CT reconstruction, the right ureter was traceable, but the left ureter was not. The left kidney shows contrast medium accumulation in the renal calyx, with no urine flow due to the renal stone. Thus, 3D-CT reconstruction would be beneficial.

Keywords

Three-Dimensional Computed Tomography, Synapse Vincent, Reconstructionm Artificial Intelligence, Transparent Image

Abbreviations

3D-CT: Three-Dimensional Computed Tomography; AI: Artificial Intelligence

Introduction

Artificial Intelligence (AI) has become more known and popular nowadays. In actual clinical practice, AI has been applied in various areas, in which radiological research has developed AI technology [1]. For long, authors and co-researchers have continued various clinical reports for diseases and/or impaired functions associated with radiological investigations. Among them, Synapse Vincent with excellent AI has been applied for the diagnosis and treatment of a variety of situations [2]. Clinical application of Synapse Vincent has been useful for detecting complex judgment of the portion morphologically and radiologically [3,4].

Recently, our radiological team had an impressive experience for a male case. He has characteristic points for the renal and ureter portion, and we can detect the detailed situation from three-dimensional CT (3D-CT) reconstruction by Synapse Vincent [5]. General information associated with related perspectives is described in this article.

Case Presentation

History and Some Exams:

The patient was a 62-year-old male. His medical history included a cholecystectomy for gallstones at age 42 and a lithotripsy for liver stones at age 52. He had been diagnosed with hypertension since age 55 and had been taking amlodipine 5 mg/day. He had a long history of alcohol consumption, which had sometimes brought unstable liver function.

Physical examination showed unremarkable findings in the head, neck, chest, abdomen, and neurological tests. His physique showed 163 cm in height, 77.4 kg in weight, and 29.1 kg/m^2 in body mass index (BMI). His recent laboratory examination was summarized in **Table-1**, in which some results of unstable liver function examination have been observed. Urinalysis revealed negative results for glucose, protein, and occult blood. Chest X-ray and electrocardiogram were within normal limits.

Results

Our radiological analysis team has applied computerized technique of Synapse Vincent so far, and reported reconstruction images of 3D-CT. In the current case with problems of renal diseases, we had tried the minute expression for reconstruction method for kidneys and ureters, in particular. Abdominal CT was conducted, and coronal views were shown (**Fig-1**). It depicted bilateral moderately larger renal cysts in bilateral kidneys (1a), and a large stone with calcification in the left kidney (1b).

The images of the abdominal CT reconstruction were shown in successive figures. Transparency method of abdominal CT reconstruction was shown (**Fig-2**). It depicted that the right ureter was traceable, but the left ureter was not (2a), and the left kidney in the contrast medium accumulation (yellow) with no urine flow due to a stone (red) (2b).

Table-1: Progress of Biochemistry Data

	2024			stand. Range	Units
	Feb 14	Apr 20	Aug 3		
CBC					
WBC	76	58	75		(x10^2/μL)
RBC	562	539	546		(x10^4/μL)
Hb	16.5	15.3	16.0		(g/dL)
PLT	20.2	20.1	20.9		(x10^4/μL)
Liver					
AST	145	27	39		(U/L)
ALT	104	33	47		(U/L)
ALP	60			38-113	(U/L)
GGT	214	39	47		(U/L)
LDH	424			124-222	(U/L)
T-Bil	1.6	0.6			(mg/dL)
Lipids					
LDL		107	116		(mg/dL)
HDL		67	73		(mg/dL)
TG		203	102		(mg/dL)
Renal					
UA		6.2	6.5		(mg/dL)
BUN	14	16	17		(mg/dL)
Cre	0.89	0.87	0.98		(mg/dL)
eGFR	68.0	69.8	61.2		(mL/min/1.73m^2)
Diabetes					
HbA1c		6.9			(%)
glucose	165	138			(mg/dL)

Case Report

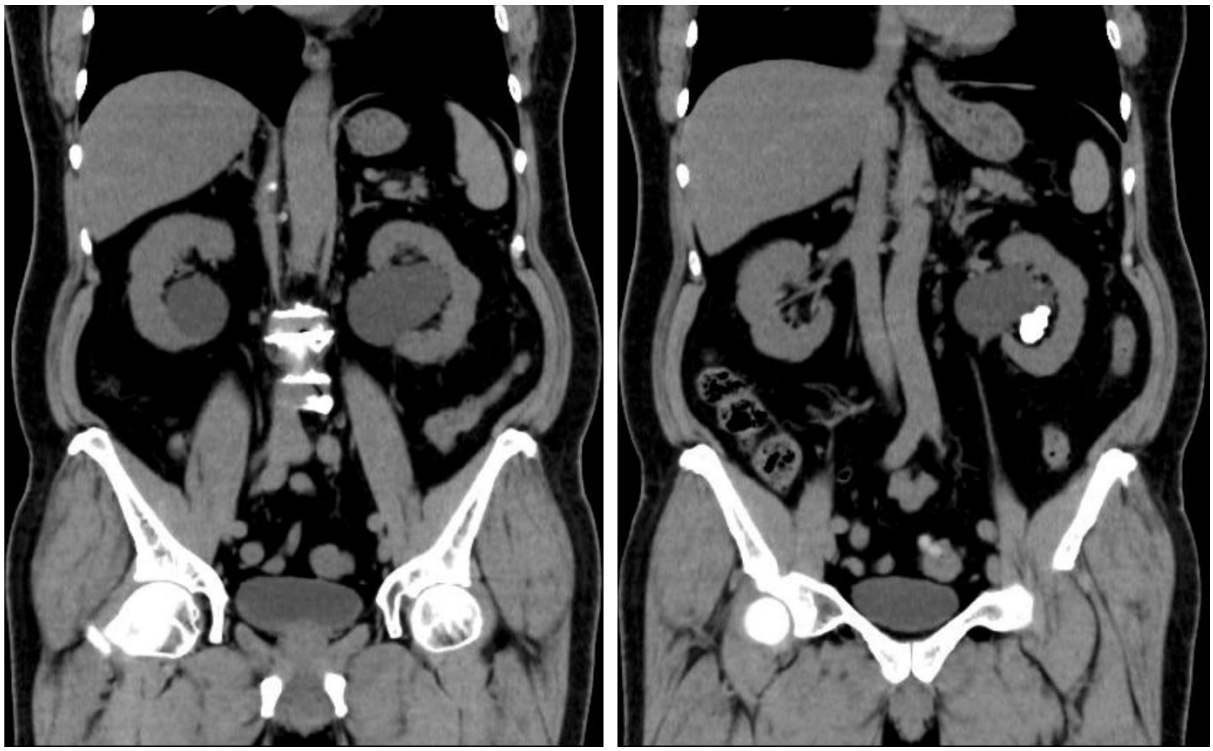

Fig-1: Coronal abdominal CT scan

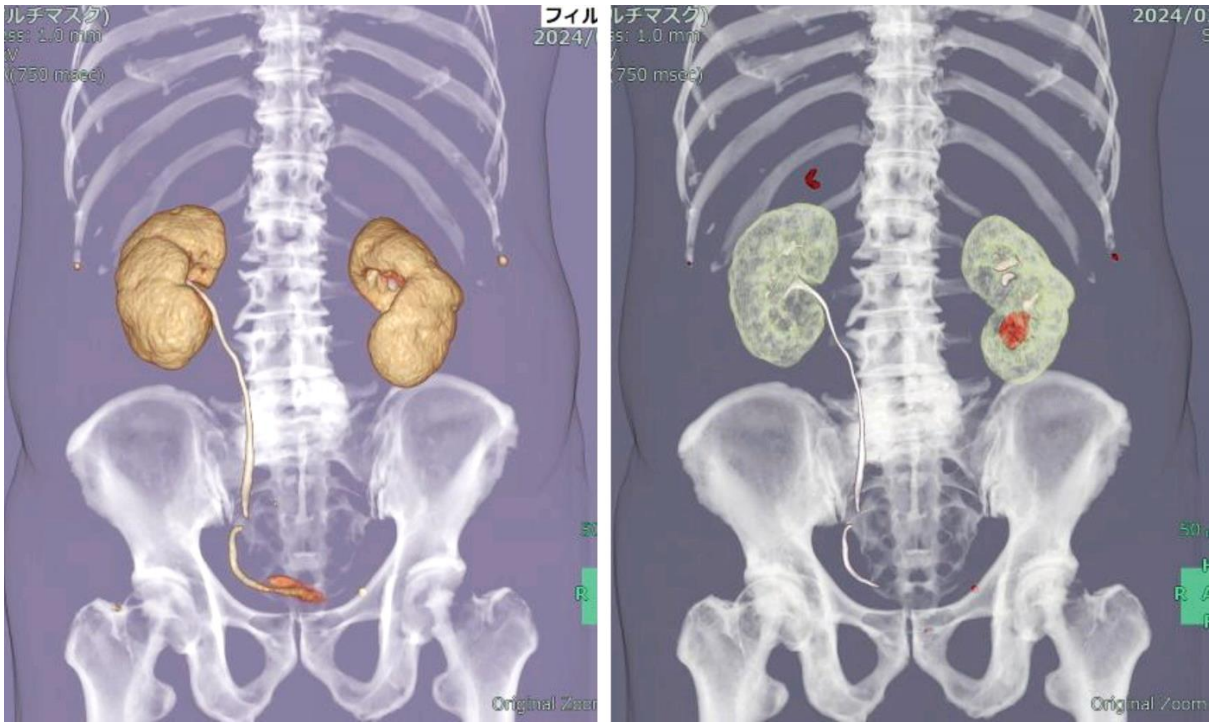

Fig-2: Abdominal CT Reconstruction (Transparency)

The additional 3D-CT reconstruction was investigated. The detailed images for the coronal view in kidneys and ureters are shown (**Fig-3**). The right ureter can be tracked, but the left ureter cannot (3a). The left kidney showed retained contrast, preventing urine flow due to a stone, and calcification is found in the right ureter (red), that might be a stone (3b).

Further 3D-CT reconstruction was conducted for the coronal section (**Fig-4**). The significant findings

included that i) probable calcification exists in the middle right ureter, ii) if the angle is changed slightly, it comes off the right ureter, iii) it was diagnosed as calcification outside the urinary tract, and iv) urine in the bladder is shown in light blue (4a). Further findings showed the front view with an image of the bones added (4b). It showed that i) the kidneys are shown as transparent images, ii) the pelvic bones are located in front of the urine in the bladder, and iii) the left femoral head is shown as a realistic image.

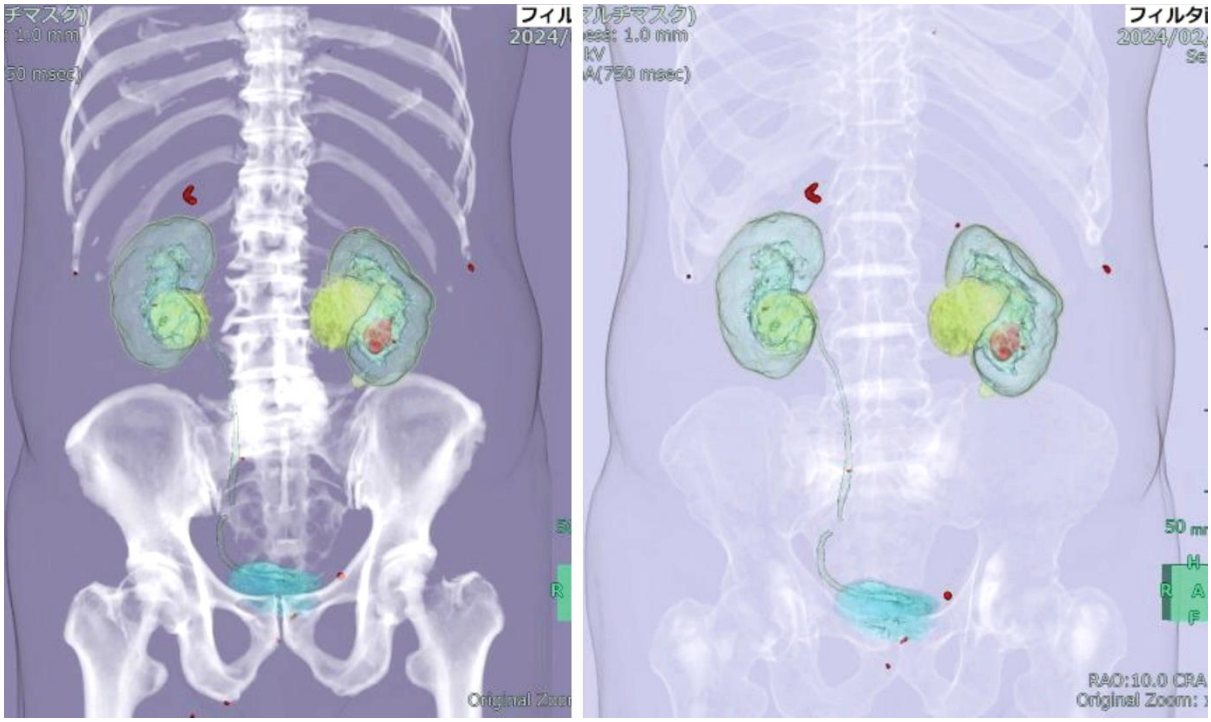

Fig-3: Abdominal CT Reconstruction (Coronal Section)

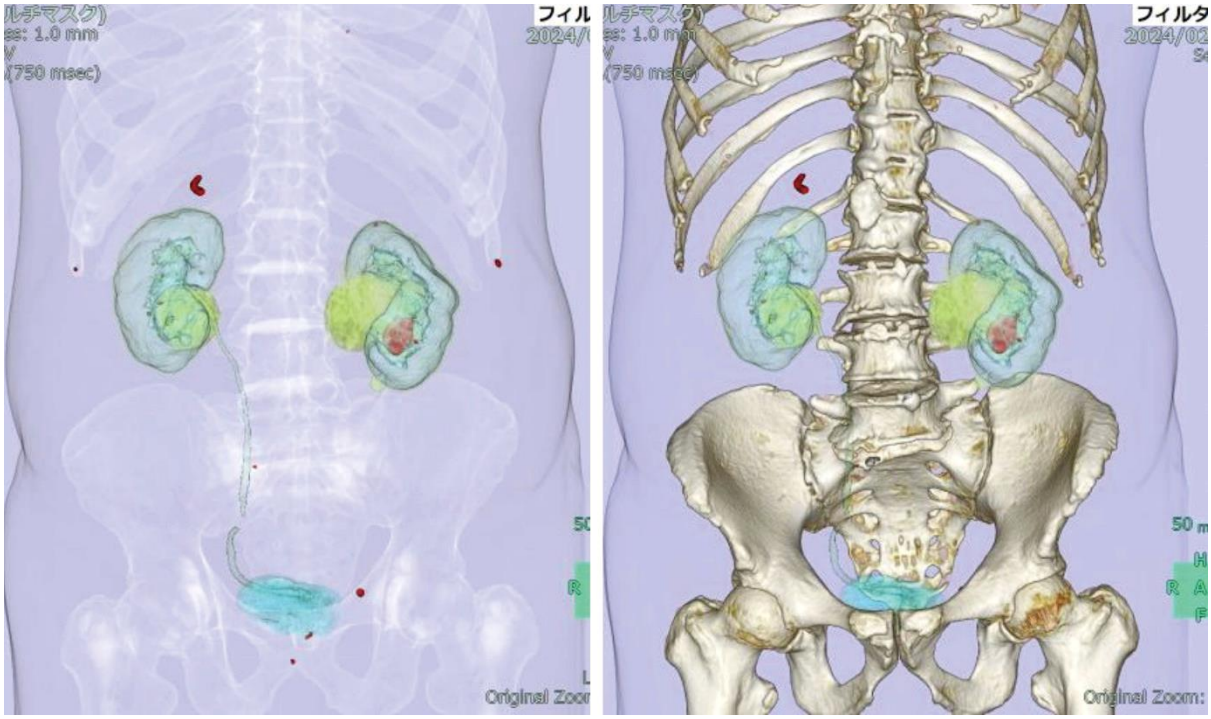

Fig-4: Abdominal CT Reconstruction (Coronal Section)

Discussion

In the current case, his related clinical problems are summarized as follows. They are #1 high blood pressure, #2 cholelithiasis, #3 alcohol consumption, #4 obesity, #5 liver dysfunction, #6 renal cyst, #7 renal stones, and #8 left renal ureteral obstruction. The clinical effects of problem #3 would be usually linked to alcoholic hepatitis, pancreatitis, hyperuricemia, renal dysfunction, and urinary tract stones. In the current case, however, these secondary complications are not so apparent. He probably has certain relationships among #3, #4, and #5, and #6 renal cyst would be due to congenital factors or predisposition.

Recently, clinical topics include the development of medical illustration, which can become a cornerstone of detailed and accurate diagnosis and treatment for many patients [6]. Among them, three-dimensional (3D) rendering has emerged as a pioneer tool, such as Synapse Vincent. It was produced in Fujifilm Medical, Japan, that can be widely embraced as a solution for three-dimension method [7]. In the case of the images of the upper urinary tract, some segmentation for arterial, venous vessels, renal parenchyma, renal calyx, ureter, and so on would be described as different colors for detection [8].

Authors and collaborators have shown several radiological reports about 3D-CT with reconstructions, Curved Planar Reconstruction (CPR), Maximum Intensity Projection (MIP), and others [9,10,11]. As the latest information about Synapse Vincent, the detection of visceral pleural invasion (VPI) in the case of early-stage non-small-cell lung cancer (NSCLC) would be possible for pre-operative prediction by the receiver operating characteristic analysis [12]. Furthermore, Synapse Vincent showed the benefit for the lung cancer cases who could not receive the enhanced CT before the operation. The protocol included diagnostic level of detailed lung anatomy between the comparison of enhanced computed tomography (ECT) and unenhanced computed tomography (UECT) [13]. As a result of statistical analyses, 3D-image by UECT data showed comparable to that of ECT for achieving pulmonary lobar and partial segmental branch degrees. Consequently, clinical achievement of Synapse Vincent has shown rapid evolution.

Some limitation may exist in the current article. He was diagnosed as renal cyst and his detailed pathophysiology was suggested by the 3D-CT. His lifestyle includes continuous alcohol consumption, and then liver function, uric acid level, renal function, renal stone and related complication will be carefully followed up in the future.

In conclusion, a 62-year-old male showed renal problems according to the 3D-CT images by Synapse Vincent. Detailed reconstructed data can bring various clinical benefits to patients. The development of 3D-CT technology will be expected in the future.

Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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