



Detail Analysis of Peripheral Artery Disease (PAD) Using SYNAPSE VINCENT Technology

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Abstract

Background: Information and communication technology (ICT) has been developed remarkably with artificial intelligence (AI) and three-dimensional reconstruction image analysis.

Patient and Method: The patient is an 84-year-old male with type 2 diabetes (T2D). The computed tomography (CT) data were analyzed by the application of SYNAPSE VINCENT system.

Results: His ankle brachial index (ABI) showed 1.16/0.65 (right/left) with large difference as peripheral artery disease (PAD). He showed calcification of aorta calcification, the occlusions of left superficial femoral artery (SFA) and right tibial artery.

Discussion: This technique can provide detail images, which contribute much for patients with arteriosclerotic cardiovascular disease (ASCVD).

Keywords: Reconstruction Image Analysis; Synapse Vincent; Superficial Femoral Artery (SFA); Ankle Brachial Index (ABI); Brachial Ankle Pulse Wave Velocity (BAPWV); Peripheral Artery Disease (PAD)

Introduction

The authors and co-researchers have continued clinical research and practice for years [1]. The reported areas include atherosclerotic cardiovascular disease (ASCVD), Type 2 diabetes (T2D) and radiological development [2,3]. Among them, recent focus would be the computed tomography (CT) scan associated with artificial intelligence (AI) assisted three-dimensional reconstruction image analysis [4,5].

For decade, rapid developments of information and communication technology (ICT) have been observed in various areas. By applying AI technology, beneficial application has been invented so far. Among them deep learning was associated with radiological three-dimension (3-D) analysis for the magnetic resonance imaging (MRI) and computerized tomography (CT) [5]. From historical point of view, 3-D imaging has been initially focused to the liver and heart, and after that to the respiratory, neurology and urological regions. In addition, orthopedics areas were initiated for precise analysis of joints such as knee joints [6]. Thus, reconstruction 3-D imaging of CT scan has been applied in the clinical practice [7]. Recently, our research group experienced

an elderly impressive patient with peripheral artery disease (PAD). In this article, general progress of the case and some perspective will be described.

Case Presentation

History and Physicals

The patient is an 84-year-old male with hypertension and hyperuricemia for about 8 years. He has provided anti-hypertensive agents (AHA) as amlodipine 5mg, valsartan 80mg and febuxostat 20mg for years. He has worked for taxi driver for long, and has been stable in recent years.

His physical examination in June 2022 showed unremarkable findings. Consciousness alert, vitals BP 132/72, pulse 64/min, SpO₂ 98%, head, neck, lung and heart were negative, abdomen is flat, and neurological test intact. His stature was 173 cm and weight 54.3kg with BMI 18.1 kg/m².

Results of basic exams

As to his laboratory examination, he has shown stable data until now (Table 1). Remarkable abnormalities were not observed in

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liver function, lipids, renal function and complete blood count (CBC). His electrocardiogram (ECG) and chest X-ray revealed negative findings.

He had the examination of mechanocardiogram and sphygmogram in July, 2022. As a result, ankle brachial index (ABI) showed large difference between right and left leg as 1.16 and 0.65 (Figure 1).

Table 1: Laboratory data of the case.

		Apr 2021	Nov 2021	May 2022	unit
Liver	AST	21	18	18	U/L
	ALT	15	13	15	U/L
	r-GT	28	32	33	U/L
Lipids	LDL	79	79	46	mg/dL
	TG	171	178	72	mg/dL
	HDL	110	104	78	mg/dL
Renal	BUN	22	23	23	mg/dL
	Cre	0.81	0.84	0.99	mg/dL
	UA	4.9	6.1	5.4	mg/dL
Glucose	Glu	119	127	94	mg/dL
	HbA1c	5.2	5.2	5.4	mg/dL
CBC	WBC	48	57	57	$\times 10^2$
	RBC	438	427	342	$\times 10^4$
	Hb	13.3	12.8	10.2	g/dL
	Ht	41.1	39.1	31.9	%
	MCV	93.8	91.6	93.6	fL
	MCH	30.4	30.1	29.8	pg
	MCHC	32.4	32.7	31.9	%
	Pit	15.1	16.3	29.9	$\times 10^4$

The data of brachial-ankle pulse wave velocity (baPWV) revealed the large difference of right vs left as 1797 vs 1318. Due to these results, his previous history was again taken in detail, and then he had the episode of muscle weakness in the left leg for a month 2 years ago.

Method for 3-D analysis

In recent medical practice, 3-D image analysis has been developed and evaluated for their detail diagnosis [8]. Among them, one of the supreme analyses would be SYNAPSE VINCENT system by Fujifilm company, Tokyo, Japan. [9]. This technique has been used for diagnostic imaging of CT, MRI and magnetic resonance angiography (MRA) for years [10]. As the authors and collaborators have taken most advantages of this software, and reported impressive clinical reports, SYNAPSE VINCENT has been used for detail radiological diagnosis this time [11].

Results

The patient received CT scan of lower arteries in Sept, 2022, which was held in plain and a contrast-enhanced procedure using iopamidol. From these data, 3-D reconstruction analysis was performed. As a result, the diagnosis would be in the following: a) several strong calcification lesions were detected in the lower aorta and in the bifurcation of the aorta (Figure 2a, b) the

occlusion of left superficial femoral artery (SFA) was found at the middle portion level of left thigh, which can be observed from multiple angle (Figure 2b and c) occlusion was found in the left anterior tibial artery and in the right three branches (Figure 2c).

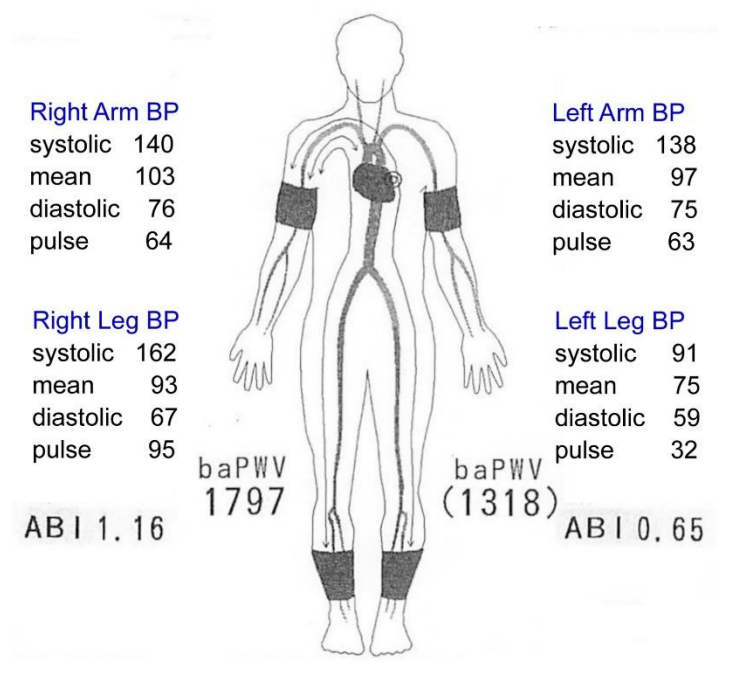


Figure 1: The results of mechanocardiogram and sphygmogram.

Discussion

Historically speaking, great development has been found for diagnostic imaging systems. Among these technologies, high-precision 3D images were initiated in 2008 from tomographic data of CT and MRI as SYNAPSE VINCENT [10]. It started in the organs of liver and heart, and it expanded for head, respiratory and urinary systems [12]. It also included orthopedic region in 2018 from knee joints analyses [13]. Recently, this technology has been widely applied for diagnostic imaging and also surgical procedure in actual medical practice. Such judgement and treatment were formerly depended on manual skill, operation and experience. However, AI technology has changed the world of operation room (OR) in recent decade.

Concerning the expanding the applied organs, the Ministry of Health, Labour and Welfare, Japan formerly had named “image-supported navigation in hepatectomy” during the early period of 3D image visualization technologies. After that, SYNAPSE VINCENT has been applied for preoperative liver functional evaluation using vascular fusion and scintigraphy [14]. Furthermore, it became beneficial method of embolization area prediction related to the transcatheter arterial chemoembolization for surgical treatment planning for liver diseases [15] and also the treatment of hepatocellular carcinoma (HCC) [16].

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In the current patient with PAD, bilateral occluded arteries in the lower extremities were found. As to his previous history, unremarkable findings were detected from lipids, renal and diabetic aspects (Table 1). Those images were presented in detail by the application of SYNAPSE VINCENT [10]. Before recognizing large difference of bilateral ABI data, the case nor medical staffs did not notice the presence of PAD (Figure 1). By image reconstruction of aorta, multiple calcifications were detected, which may suggest the development of arteriosclerosis of large vessels (Figure 2a). For the occlusion of left SFA, collateral artery may contribute maintaining the blood flow (Figure 2b). Several aspects of rotating angles enable to observe detail changes of SFA. Further, the lesions were clearly captured in clear images by optimizing the processing of image reconstruction, where such technique will contribute further development of radiological diagnosing and treatment (Figure 2c).

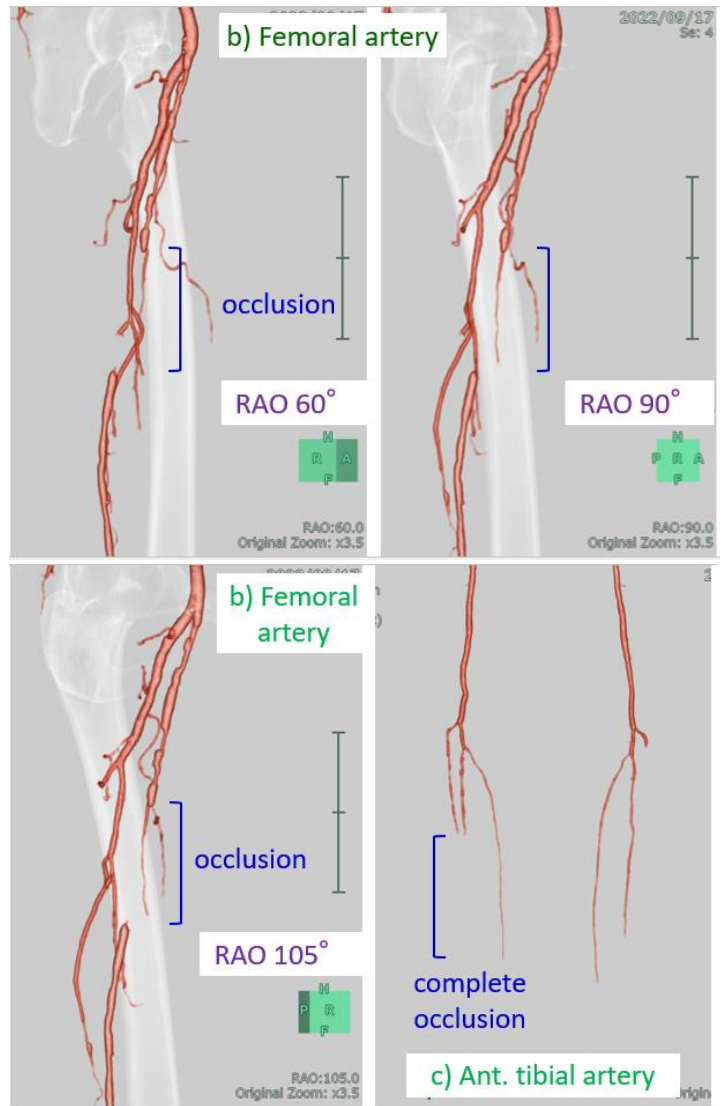
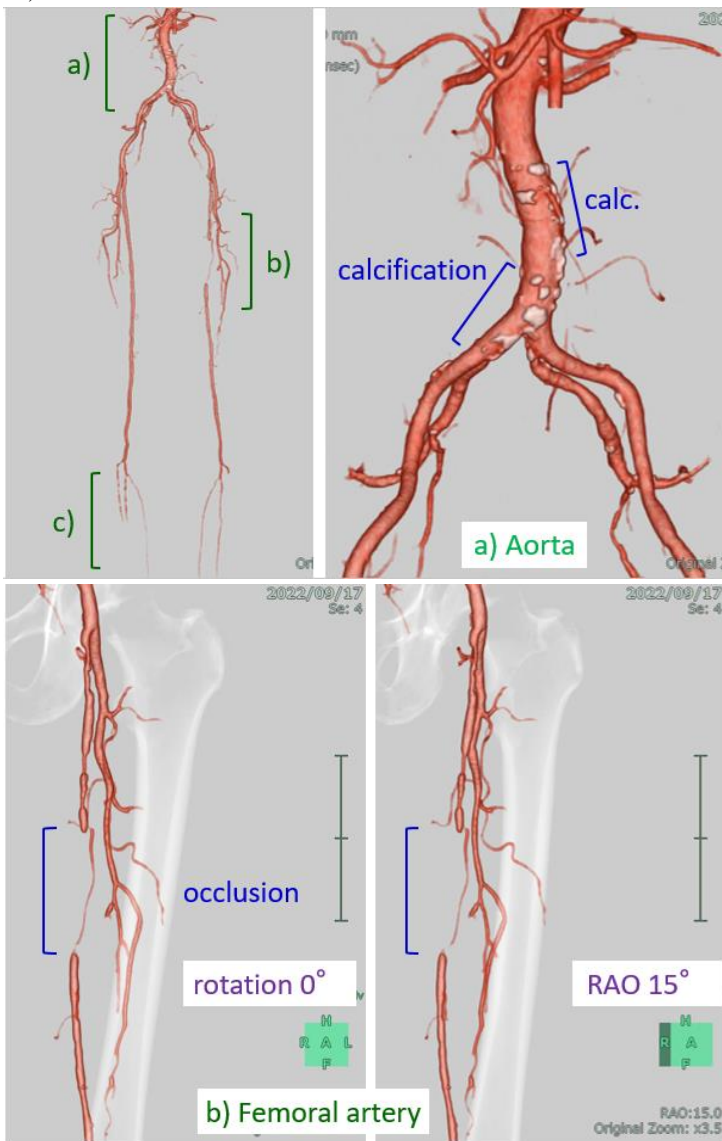


Figure 2: Reconstruction imaging using SYNAPSE VINCENT system

2a: The calcification lesions exist in the bifurcation of the aorta.

2b: The occlusion of left femoral artery was found.

2c: The occlusion of bilateral anterior tibial arteries was noted.

Similar latest report is found, where a 70-year-old man with left SFA occlusion received further evaluation [17]. The method was the motion imaging with intravoxel incoherent way, which showed the improvement of lower limb perfusion after endovascular treatment for lower extremity arterial disease. The changes in ABI before and after treatment were 0.46 and 1.06, which revealed remarkable improvement. In recent years, the development and enhancement of various computers have been observed. Furthermore, radiological techniques of medical imaging have become more useful with related improved software. Consequently, clinicians can be more easily accessible for diagnosis and treatment of vascular diseases. Until now, several evolutionary novel methodologies have found for



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visualizing of blood flow in vascular diseases with time-varying blood flow structures and quantification [18]. The combined procedure would be beneficial, such as computational fluid dynamics (CFD) method and also 3-D, time-resolved, phase-contrast MRI method (4D-flow MRI).

Some limitations are present in this report. Current case has been treated for hypertension, and was proved to have PAD this time. Other ASCVD lesion may exist for future evaluation.

In summary, the reconstruction image analysis method and its application for blood vessels were described. By the application of SYNAPSE VINCENT, detail images of vascular abnormalities can be obtained for lower extremity and lumbosacral region [19]. Our clinical group will follow up the case and continue various trials for novel combination of radiological diagnostic procedures.

Conflicts of Interest: None.

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