

CASE REPORT

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## Clinical usefulness of multiplanar reconstruction images obtained by multi-slice computed tomographic angiography for early-stage Takayasu's arteritis

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**Abstract** We describe a case of Takayasu's arteritis discovered during the early stage (prepulseless stage). Cervical ultrasonography and multiplanar reconstruction (MPR) images obtained by computed tomography (CT) showed thickening and stenosis of the walls of the common carotid arteries. However, magnetic resonance arteriography (MRA), volume rendering (VR) imaging CT, and maximum intensity projection (MIP) imaging CT could detect no obvious abnormality. We emphasize the importance of noninvasive vascular investigation with cervical ultrasonography and MPR imaging CT to support the diagnosis of early-stage Takayasu's arteritis.

**Key words** Cervical ultrasonography · Early stage · Multiplanar reconstruction (MPR) image · Multislice computed tomography · Takayasu's arteritis

### Introduction

Takayasu's arteritis is a chronic inflammatory disease occurring mainly in young women, affecting medium-size and large arteries, and characterized by a strong predilection for the aorta and its branches and the pulmonary arteries.<sup>1</sup> The disease may show a biphasic clinical course: an early acute

inflammatory phase characterized mainly by systemic symptoms such as fever, anorexia, and arthralgia, and a chronic phase with arterial occlusive symptoms such as hypertension and pulselessness.<sup>2</sup> Diagnosis is usually confirmed by angiography at the chronic phase when symptoms of arterial occlusion are evident. At the chronic phase, angiography is the best means of showing irregular vessel walls, stenosis, poststenotic dilatation, and aneurysm formation of the aorta and its branches. A diagnosis using diagnostic criteria can be made only at the chronic phase.<sup>3</sup>

However, this method is invasive and does not demonstrate the involvement of the mural wall, which is a major pathologic feature of Takayasu's arteritis. Angiography only visualizes the resulting luminal narrowing and dilatation, which is present in the later stages of the disease.

Recently, spiral (helical) computed tomography (CT) angiography has been developed, which allows a reconstruction of three-dimensional volume data from multiple projectional data sets obtained from multi-slice CT. In particular, multiplanar reconstruction (MPR) imaging with multi-slice CT data allows the clinician to reconstruct a cross-section in any plane, thanks to the progress in CT imaging that can now routinely yield very thin sections of the body. The use of MPR imaging CT has been shown to be useful in several areas of the body, including the brachial plexus, spine, and skull, and can help to visualize aortic dissection, musculoskeletal tumors, and anomalies of the face.<sup>4</sup>

We describe the case of a woman with Takayasu's arteritis, which was discovered at the early stage using a noninvasive vascular investigation with cervical ultrasonography and MPR imaging CT.

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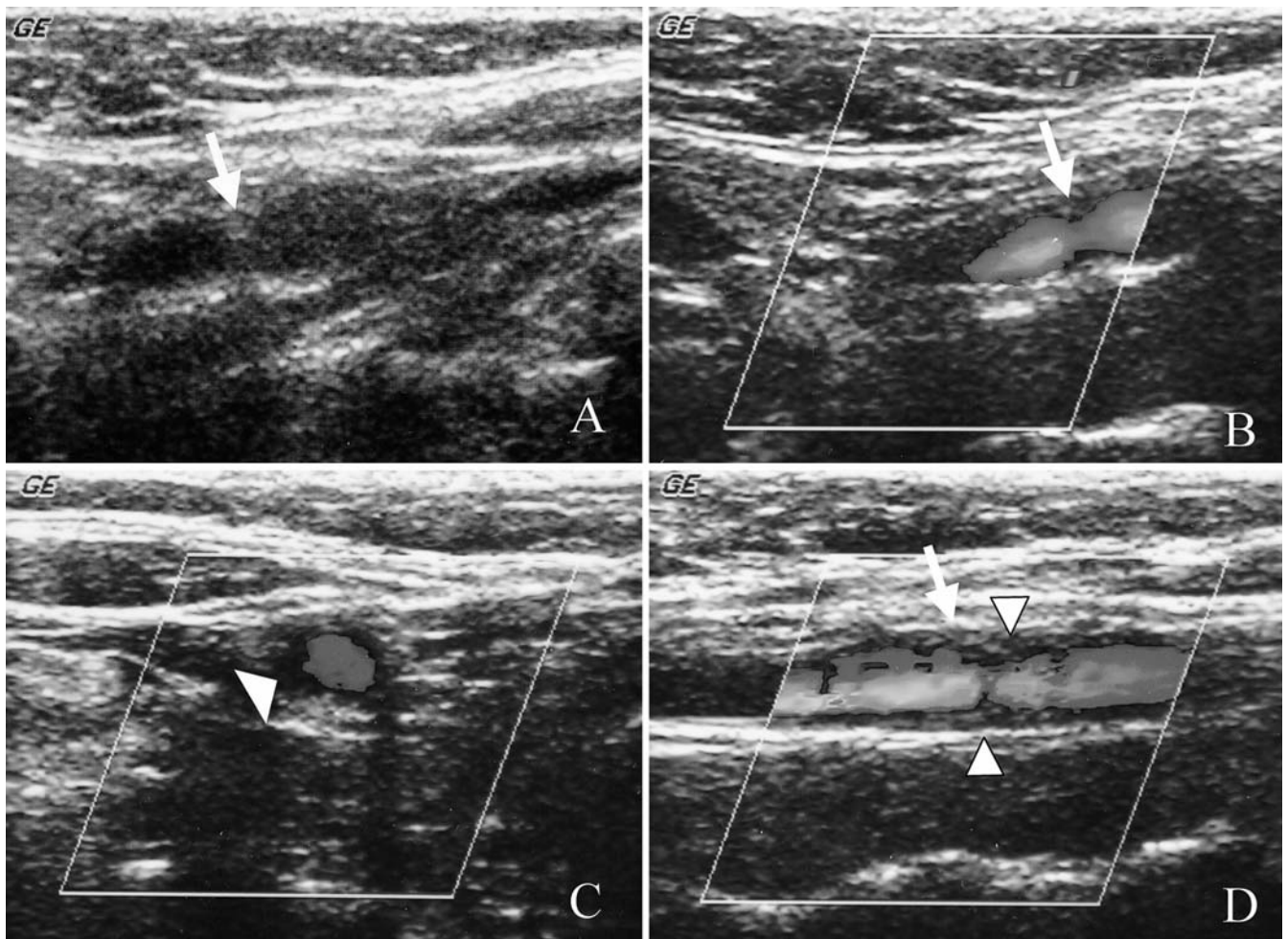
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### Case report

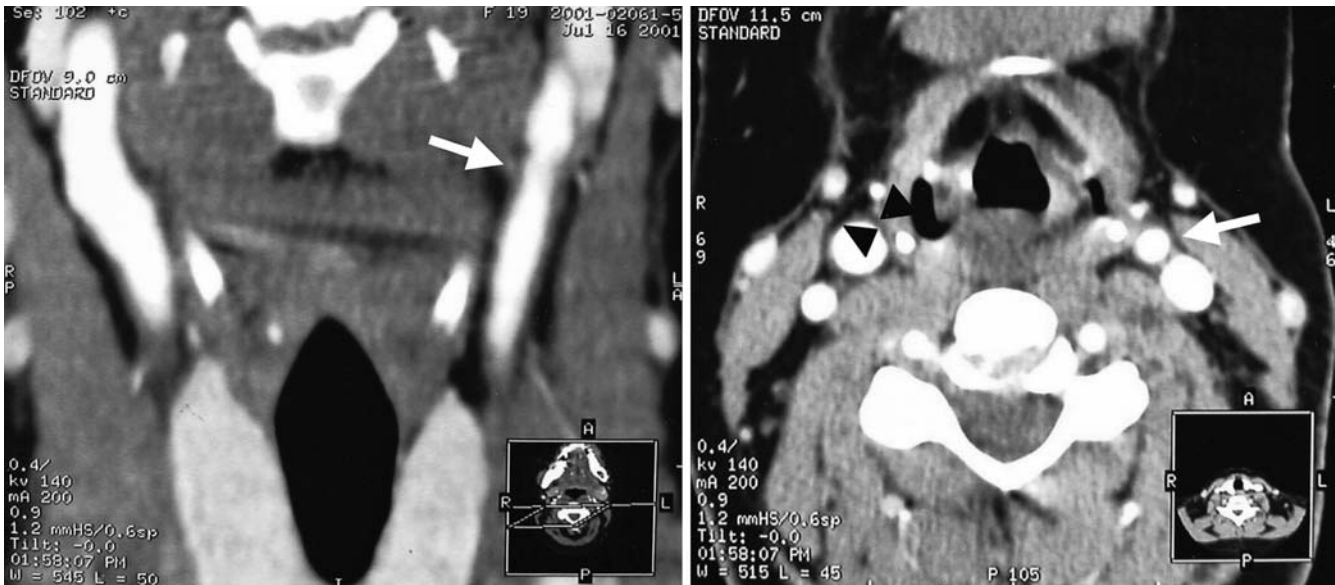
A 19-year-old woman was admitted to Matsuyama Shimin Hospital in October 2000 because of a high spiking fever that was resistant to antibiotics. At admission, a clinical



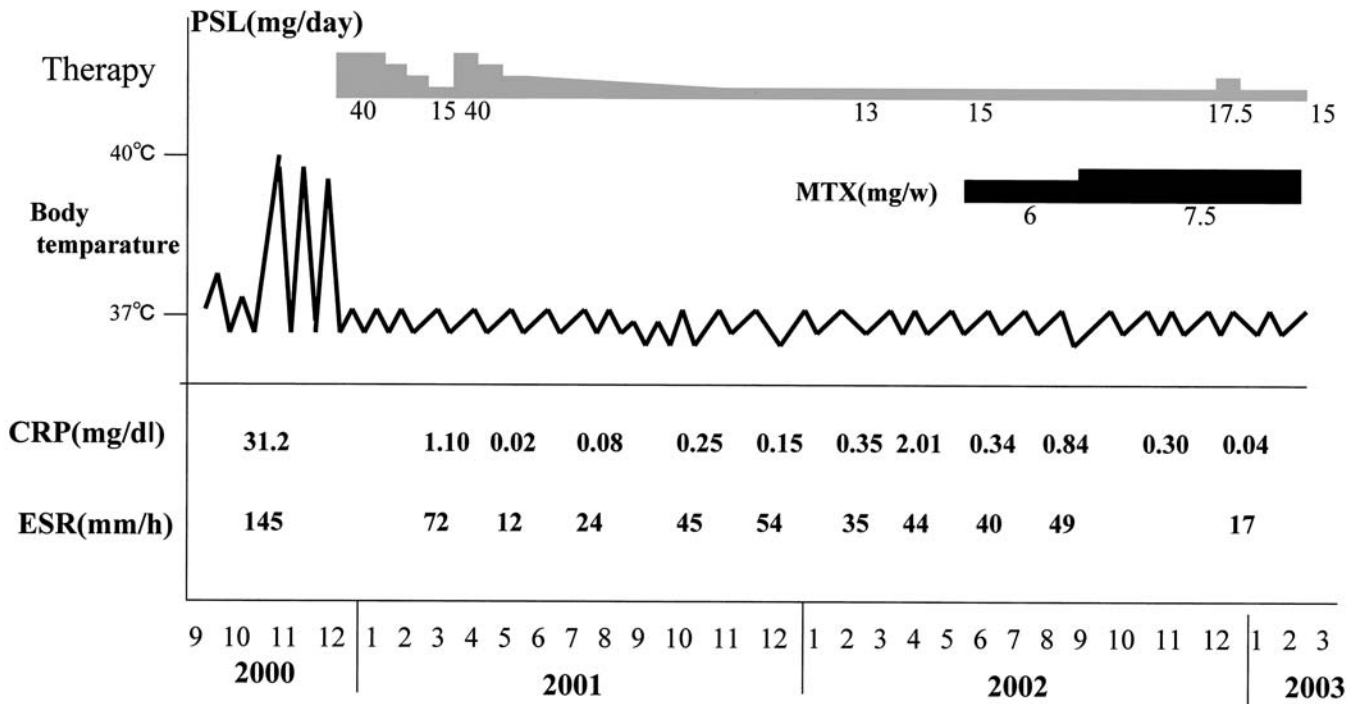
**Fig. 1.** Ultrasonographic findings in the common carotid artery (CCA) and internal carotid artery (ICA). **A–C,** ICA; **D,** CCA; mural thickness (arrowheads) and stenosis (arrows) of the artery are shown in both ICA and CCA

examination showed no other abnormality. Laboratory tests revealed a sedimentation rate of 145 mm/h, and a C-reactive protein level of 31.2 mg/dl. Other biological data were normal. Ultrasonography of the carotid artery showed mural wall thickening, and Takayasu's arteritis was suspected. However, thoraco-abdominal CT and thoracic 3D-enhanced magnetic resonance arteriography (MRA) displayed no obvious abnormality. The patient was diagnosed as having collagen disease without definite diagnosis, and treatment with prednisolone (40 mg/day) was started. A substantial improvement was seen and she became free of most symptoms. She maintained a good clinical condition in clinical manifestations and laboratory data (C-reactive protein <0.25 mg/dl). When prednisolone was tapered to 15 mg/day, she again began to complain of malaise and low-grade fever. She was therefore referred to Ehime University Hospital for confirmation of the diagnosis in March 2001. Upon presentation at our hospital, both radial pulses in the patient were easily palpated and regular. Clinical examinations, including auscultation of the heart and blood vessels, gave normal findings. Laboratory findings were normal except for increases in the erythrocyte sedimentation rate (72 mm/h), and levels of C-reactive protein (1.10 mg/dl)

and serum amyloid A protein (20.5  $\mu$ g/ml). Antinuclear antibody, rheumatoid factor, disease-specific autoantibodies, and anti-neutrophil cytoplasmic antibodies were all negative. Complements (C3, C4, and CH50) were within normal ranges. Ultrasound examination of the carotid artery showed thickening of the wall and stenosis (Fig. 1). To confirm the diagnosis, thoracic dynamic MRA and multislice CT were performed. Dynamic MRA could not detect any obvious abnormality. Volume rendering (VR) imaging and maximum intensity projection (MIP) imaging CT also detected no obvious abnormality. MPR imaging CT revealed mural wall thickness and stenosis of the carotid artery (Fig. 2). Other causes of large-vessel abnormalities were excluded based on clinical criteria and serological studies. We concluded that the patient had Takayasu's arteritis, and her dose of prednisolone was increased (40 mg/day) again. Thereafter, she showed a marked improvement in both clinical symptoms and laboratory data, and had a good clinical course with prednisolone and methotrexate therapy for more than 2 years (Fig. 3).



**Fig. 2.** Multiplanar reconstruction (MPR) imaging computed tomography. Obvious stenosis of the left common carotid artery is detected (*white arrows*), and mural thicknesses of the bilateral common carotid artery are shown (*black arrowheads*)



**Fig. 3.** Clinical course of the patient. *PSL*, prednisolone; *MTX*, methotrexate

## Discussion

Early diagnosis of Takayasu's arteritis has been difficult owing to its nonspecific systemic symptoms and signs. However, early diagnosis is very important in order to reduce the occurrence of further vascular damage by the institution of corticosteroid and immunosuppressant therapy. Conventional catheterization angiography and digital subtraction angiography (DSA) have been considered the gold stan-

dard in delineating abnormal vessels to diagnose late luminal changes in the disease. However, these methods are invasive and do not show the involvement of the vessel walls, because they visualize luminal stenosis and dilatation only in the later stage of the disease. Recently, ultrasonography,<sup>5,6</sup> MRI,<sup>7-9</sup> and CT,<sup>8,10-16</sup> have increasingly been utilized as noninvasive imaging modalities for the diagnosis of early-stage Takayasu's arteritis.

Ultrasonographic examination of the carotid artery is noninvasive, highly sensitive, and relatively inexpensive for

diagnosis of the disease; however, the method is delicate and sometimes shows artifacts. Therefore another method is needed for a definite diagnosis of Takayasu's arteritis, and also for screening examinations and long-term repeated follow-up. Miller et al.<sup>17</sup> reported that MRI is inadequate as a screening examination or for detailed evaluation compared with angiography. However, with advances in equipment and technology, MRI has become highly effective for a diagnosis of early-stage Takayasu's arteritis. Choe et al.<sup>9</sup> and Tanigawa et al.<sup>18</sup> suggested that MRA was a useful approach for detecting the initial changes in the aorta and pulmonary artery in Takayasu's arteritis. Iwamoto et al.<sup>7</sup> reported that gadolinium-enhanced MRI of the aortic wall is useful for diagnosis in the early stage. Yamazaki et al.<sup>13</sup> and Morita et al.<sup>14</sup> reported that the initial mural thickness can be detected with plain CT. Spiral CT has recently been developed, based on the principles of continuous scanning during constant X-ray tube rotation and table movement (multi-slice CT). It is now possible to perform very fast imaging of a large body volume, with optimal vessel enhancement, in a single breath hold with a single injection of contrast material. In addition, image processing can provide a three-dimensional image of the thoracic and abdominal aortae and their branches. Some reports have described the diagnosis of Takayasu's arteritis using 3D imaging with multi-slice CT angiography.<sup>10,16</sup> This method is very sensitive, like ultrasonography and angiography, and is more objective than ultrasonography for carotid examination. Lambert et al.<sup>12</sup> reported the case of a patient with Takayasu's arteritis which was discovered at the early phase using ultrasonography and CT, despite normal findings on angiography. In previous reports, the sensitivity of 3D reconstructions imaging CT, MIP imaging CT, and MRI in the diagnosis of internal carotid artery stenosis has ranged between 80% and 92.8%, 50% and 92%, and 54% and 96%, respectively.<sup>19</sup> The differences in these values are thought to be caused by different scanning parameters. Now that multi-slice CT technology has advanced markedly, an improved resolution can be obtained when CT data are reconstructed out of the plane. MPR imaging can also be obtained by MRI, making it a very useful method for the diagnosis of vascular disease. The advantage of MPR-CT angiography is higher resolution and a smaller influence of the blood flow than MPR imaging of MRI, thus allowing a more precise diagnosis and estimation of the extent of disease involving the blood vessels than is possible with MRI. The process of reconstruction in VR and MIP imaging involves a loss of CT data, whereas MPR can reconstruct images from total CT data. Therefore, MPR images can show finer details of blood vessel abnormalities than VR and MIP imaging. Other advantages of MPR-CT angiography are summarized in Table 1.

As this method can detect small changes in blood vessels, it might be very useful for assessing the effects of treatment as well as diagnosis. However, very thin slices are required for precise imaging, and this increases the level of radiation exposure. As Takayasu's arteritis occurs in young women, we must consider the advantages and the disadvantages if it is necessary to carry out this method repeatedly.

**Table 1.** Advantages and disadvantages of MPR-CT angiography

Advantages
Noninvasive compared with conventional catheterization angiography and digital subtraction angiography
Higher resolution and smaller influence of blood flow compared with MRI
Provides any defined plane and vascular vessel wall images, as MRI does
Smaller loss of CT data in the process of MPR imaging compared with VR and MIP imaging
Detects calcification of blood vessel walls
More objective than ultrasonography
Short examination time
Practicable for patients with metal apparatuses in the body
Disadvantages
Radiation exposure
Uses iodine contrast medium
Resolution varies depending on equipment

In our patient, we assessed the effects of treatment using ultrasonography and contrast CT without MPR imaging, and no changes were noted with regard to the degree of stenosis or mural wall thickness. Although we have no evidence for the merits of early medication for Takayasu's arteritis, we think that our patient could have been spared further vascular damage due to the disease because of the early diagnosis.

MPR-CT angiography is now used for large-vessel diseases such as aneurysms and stenosis in patients with advanced Behçet's disease as well as Takayasu's arteritis. With progression of the technology, it will become a more useful and common method than DSA for early diagnosis of Takayasu's arteritis and small-vessel abnormalities such as microaneurysms in polyarteritis nodosa.

The patient described in this paper was diagnosed as having Takayasu's arteritis in the early stage using noninvasive ultrasonography and multiplanar reconstruction imaging CT. Since Takayasu's arteritis was strongly suspected upon ultrasonography examination, angiographic MRI and multislice CT were performed. However, thoracic dynamic MRI could detect no obvious abnormality. VR imaging and MIP imaging CT were unable to demonstrate carotid stenosis, and the patient fulfilled only one ACR criteria – age under 40 years. MPR imaging CT showed obvious stenosis and mural thickness of the carotid artery. The failure of VR and MIP imaging CT to detect obvious mural thickening and stenosis may have been due to very small mural changes in the carotid artery, because the patient was in a very early stage of the disease. She showed no clinical manifestations other than malaise and fever, and had no ischemic symptoms.

These results suggest that 3D imaging by CT, especially MPR imaging CT, is helpful for the early diagnosis of Takayasu's arteritis.

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