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ULTRASOUND IMAGE OF THE MONTH

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Tissue structure of arterial wall revealed with elasticity imaging

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Ultrasonic elasticity imaging

A 63-year-old patient with arteriosclerosis obliterans was scheduled to undergo bypass grafting surgery. Figure 1a shows a B-mode image of the femoral artery transcutaneously scanned by conventional diagnostic equipment (EUB-655; Hitachi) before the surgery. The right edge of the B-mode image in Fig. 1a was kept 20 mm away from the distal bifurcation so as to make the position of the pathological image coincide with that of the elasticity image.

As shown in Fig. 1a, the measured region shows diffuse intimal thickening. An elasticity image of the posterior wall was obtained (Fig. 1b) using the phased tracking method proposed by our group.[1–3] In Fig. 1b, the measured elasticity image shows a layered structure. The luminal and outer regions are hard, and the region in the middle of the posterior wall is softer than the luminal and outer regions.

Discussion

The measured elasticity image was compared with the pathological image of the corresponding section made after the surgical extraction. During bypass grafting surgery, a string was tied to the external surface of the anterior wall for identification of the anterior and posterior walls, and the artery was then dissected and extracted by referring to the distance (20 mm) between the measured region and the distal bifurcation.

The pathological image of the corresponding region is shown in Fig. 1c, and an enlarged view of the region surrounded by the cyan line in Fig. 1c is shown in Fig. 1e. In Fig. 1c and 1e, collagen, smooth muscle, and elastin are stained in blue-green, red, and black, respectively. For detailed comparison of the measured elasticity distribution with the pathological image, Fig. 1d shows the elasticity distribution along the ultrasonic beam in the region surrounded by the cyan line in Fig. 1b. Surprisingly, the layered tissue structure in Fig. 1e corresponds to the layered structure as revealed by the elasticity image shown in Fig. 1b as well as the elasticity distribution shown in Fig. 1d. The hard luminal region (Ra) in Fig. 1d was found to correspond to the collagen-rich region of the intima and a part of the media in Fig. 1e. The relatively soft region (Rb) in the middle of the wall in Fig. 1d corresponds to the remaining part of the media with smooth muscle (Fig. 1e). The outer hard region Rc in Fig. 1d corresponds to the collagen-rich adventitia in Fig. 1e. These results show that the elasticity image measured by the newly developed transcutaneous ultrasound method[1–3] successfully reveals the tissue structure of the arterial wall.

Computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography, in which the morphology and angiographic lumen of the artery can be evaluated, are used for conventional diagnosis of atherosclerosis.[4–6] However, it is difficult to evaluate the regional mechanical properties of the arterial wall. Elasticity imaging with transcutaneous ultrasound provides additional useful information for diagnosis of atherosclerosis in clinical situations. Furthermore, the proposed method can be installed in diagnostic ultrasound systems provided by various manufacturers. The ultrasound systems provided by Toshiba Co., Ltd. (Tokyo, Japan) and Aloka Co., Ltd. (Tokyo, Japan) have already been used in our research,[3,7] and real-time equipment for elasticity imaging of the arterial walls is being developed by Panasonic Co., Ltd. (Kanagawa, Japan) for clinical studies.[8]

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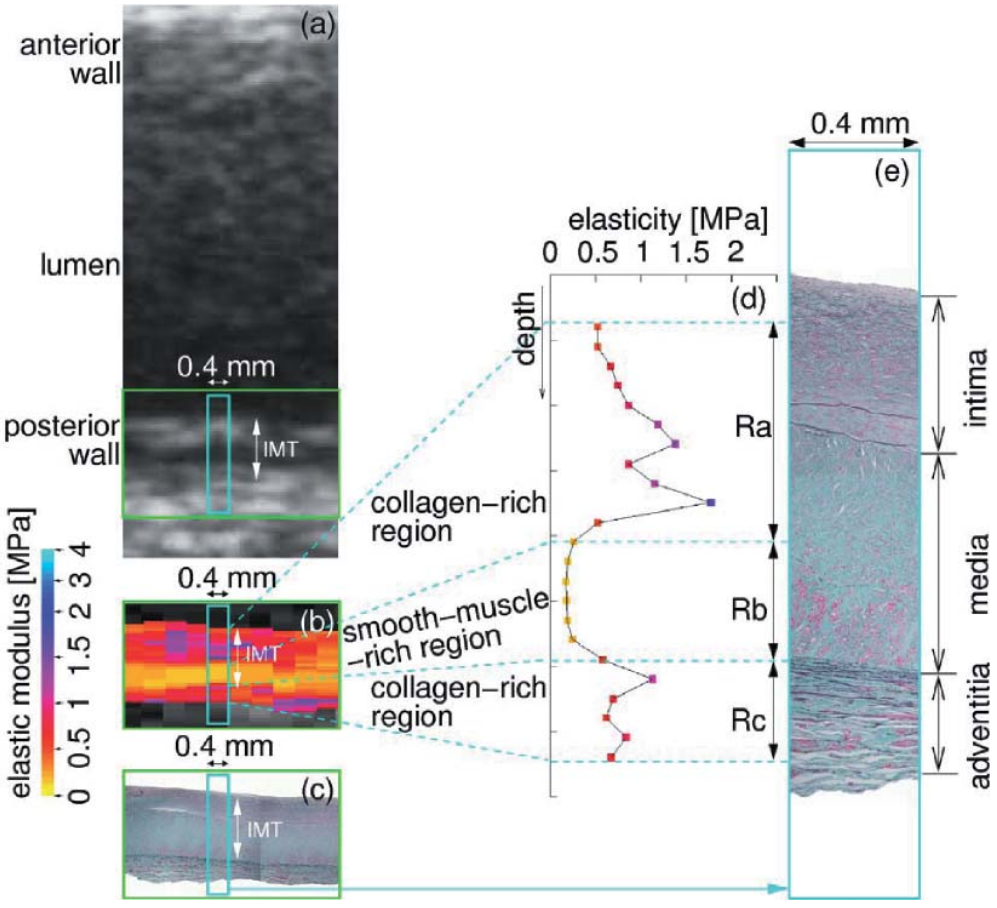

Fig. 1. **a** Ultrasonic B-mode image of the femoral artery of the 63-year-old male patient. The right edge of the B-mode image was kept 20 mm away from the distal bifurcation. **b** Elasticity image of the posterior wall in the region surrounded by the *green line* in **a**. **c** Pathological image of the measured region in the posterior wall. **d** Radial elasticity distribution along the ultrasonic beam, which corresponds to the region surrounded by the *cyan line* in **b**. **e** Enlarged view of the region surrounded by the *cyan line* in **c**

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