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# Fundamentals for the Difference of Tissue Structure between Large Elastic Arteries and Muscular Arteries

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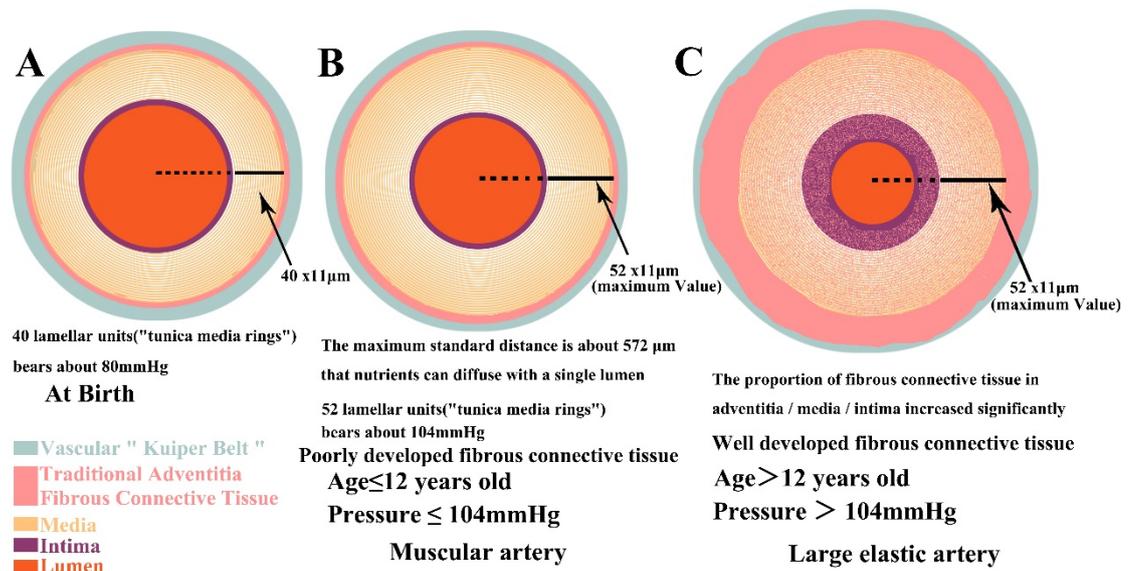


Figure 1. Fundamentals for the difference of tissue structure between large elastic artery and muscular artery

## Main text

Previous studies have shown the major role of hydrostatic pressure in vascular

development, remodeling and degradation<sup>1-13</sup>. In fetal vascular development, hydrostatic pressure determines the thickness of blood vessels<sup>7</sup>, and blood flow determines the size of lumen<sup>4,6</sup>, which is the adaptive remodeling of vascular tissue to hydrostatic pressure / blood flow. The principles of physics / mathematics are universal in the process of vascular development<sup>7</sup>, remodeling and degradation<sup>7</sup>, such as atherogenesis<sup>7</sup>, blood vessels to ligaments transition<sup>4</sup>, pathogenesis of vascular chronic total occlusion (CTO)<sup>6</sup> or formation of perivascular adipose tissue<sup>5,7-9,14</sup>. These processes cannot be explained by the changes of a single molecule, but should by the " Central Dogma " of Tissues<sup>5</sup>. Based on human vascular anatomy and the principles of mathematics / physics<sup>1,2,5,7</sup>, this paper attempts to explain the relationship between the change of blood pressure and the development of tunica media, so as to explore the fundamentals for the difference of tissue structure between large elastic arteries and muscular arteries (Figure 1).

The normal value of human systolic pressure at birth is about 80mmHg (Figure 1A). Within the age of 12 years, the calculation formula of the normal value of systolic pressure is:  $80 + 2 \times \text{age (years)}$ . At the age of 12 years, the systolic pressure is about  $80 + 2 \times 12 = 104\text{mmHg}$  (Figure 1B). There are about 40 lamellar units (One lamellar unit  $\approx 11\mu\text{m}$  thick) of smooth muscle cell in the human aorta at birth (Figure 1A)<sup>15</sup>. Number of lamellar units increases from 40 at birth (Figure 1A) to about 52 at most in one's lifetime (Figure 1B, 1C)<sup>15</sup>. We can easily find that 40 lamellar units corresponds to 80 mmHg and 52 lamellar units corresponds to 104 mmHg. As the pressure increases by 2 mmHg per year, the media increases one lamellar unit per year, which is similar to

the “tree ring”, so I name one “lamellar unit” as one "tunica media ring". I speculate that one "tunica media ring" would be added to the media every year, from 40 "tunica media rings" at birth to 52 "tunica media rings" at the age of 12 years, and the smooth muscle cells in the artery could no longer be easily formed after age of 12 years. Therefore, the ability of vascular regeneration / repair in muscular arteries / large elastic arteries is relatively strong before the age of 12 years, and the regeneration ability may be significantly weakened after the age of 12 years. If various risk factors lead to significant loss / dysfunction of smooth muscle cells, the possibility of forming atherosclerotic diseases, aneurysms or stiffening would be significantly increased after the age of 12 years.

Under normal physiological conditions, there are no capillaries in the tunica media, and the nutrients of the media come from the dispersion of the lumen / vasa vasorum<sup>15</sup>. Due to the limitation of diffusion distance, the tunica media cannot thicken without limitation (The normal maximum dispersion distance  $\approx 11 \times 52 = 572\mu\text{m}$ , Figure 1B). There are at least two lumens at the arterial bifurcations to supply the nutrients of the ridge of bifurcations, so the ridge of the arterial bifurcations can be significantly thicker (Significantly thicker than  $572\mu\text{m}$ ). Therefore, the maximum pressure that the normal adult human tunica media (52 "tunica media rings" without obvious fibrosis nor the ridge of bifurcations) could bear is about 104mmHg (Figure 1B). The pressure exceeding 104mmHg must be borne by the tissue of intima / adventitia or the fibrous connective tissue of the tunica media (Figure 1C). Under normal physiological conditions, since the pressure in large elastic arteries (higher than 104mmHg) is higher

than that in the muscular arteries, the intima / adventitia / media of large elastic arteries bears higher pressure (higher than 104mmHg), and the pressure exceeding 104mmHg leads to the better developed fibrous connective tissue in the intima / adventitia / media of large elastic arteries than that of the muscular arteries (Figure 1C)<sup>1-14,16-20</sup>. This is the main reason for the obvious differences in the content of fibrous connective tissue of intima / adventitia / media between the large elastic arteries and the muscular arteries (Figure 1)<sup>15</sup>. Arteries are continuous pipes. The discontinuity of development, remodeling or degradation of vascular tissues is caused by different pressure / flow of fluids, which cannot be explained by a single molecule, but by the "central dogma" of tissues<sup>5</sup>. At the same time, the development, remodeling or degradation of vascular tissues would also affect pressure / blood flow<sup>1-14,16-20</sup>.

104mmHg / 52 "tunica media rings" might provide a theoretical basis for the target value of controlling human systolic pressure, which needs to be proved by clinical trials in the future.

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