Age variations in the internal radii of human arteries

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Introduction

INTERNAL DIAMETER OR RADIUS is the most important dimension of an artery in the dynamics of the cardiovascular system. (Abramson, 1962 & 1967). An accurate measurement of it by direct method in vivo is not easily obtained. It may be determined from arterial segments of a cadaver after histological sections. Even this is also not easy, because of the changes due to post-mortem contracture of the arterial wall in addition to those produced by histological processing.

Some workers have measured the internal calibre of blood vessels by angiography and established a pressure-radius relationship of the blood vessels. (Luchsinger, et al 1962; Schobinger, et al 1964; and Lerhrer, 1968). Others have done the same by direct method and determined the external diameters of arteries during a surgical operation or otherwise. (Rushmer, 1955; Greenfield, et al 1962; and Reich, et al 1964). Many methods of measuring this dimension are on record in the literature. (Reynold, 1952; Saunders, et al 1954; and Rushmer, 1955; also Turner, 1957; Luchsinger, et al 1968; & Wiederhielm, 1963).

This present study is an endeavour to estimate the internal radii of some specific arteries, both elastic and muscular, by direct method and to observe the variations in them due to ageing. Though these measurements were obtained after death, yet they represent the actual radii of these blood vessels during life. A simple but fairly accurate method has been applied to measure them.

Materials and Method

A random investigation has been made on the arteries of 50 apparently healthy and fresh cadavers of different ages — mostly from accidental deaths. Cross-sections from selected sites of the following arteries, viz; Subclavian, Internal Carotid, Internal Iliac, Renal and Coronary arteries were made and histologically prepared. Slides of these stained sections were projected on a screen to a desired magnification (x 20). The inner margins of these arterial shadows were carefully traced on a paper and then measured with an opisometer (map-measurer). (Turner, 1957; Pallie, et al 1962). The resultant measurements were scaled down to proper lengths and converted into millimeters which represented the true inner circumferences of these arteries. The calculated numbers were then used to find the radii from a mathematical formula, $C = 2\pi r$, where, C = circumference, r = radius and $\pi = 22/7$. These results were put on scatter-graphs according to age and the corresponding measurements. This is shown in the following scatter-graphs. (Figs. 1, 2, 3, 4 & 5).

Results

From the study of these scatter-graphs, it is observed that there is a gradual increase in the internal calibres of these arteries as age advanced. This change is found both in elastic and muscular arteries with a few exceptions. Nevertheless, the mean graph-line on both sides of which the scatters are equally distributed, shows a steady upward inclination indicating

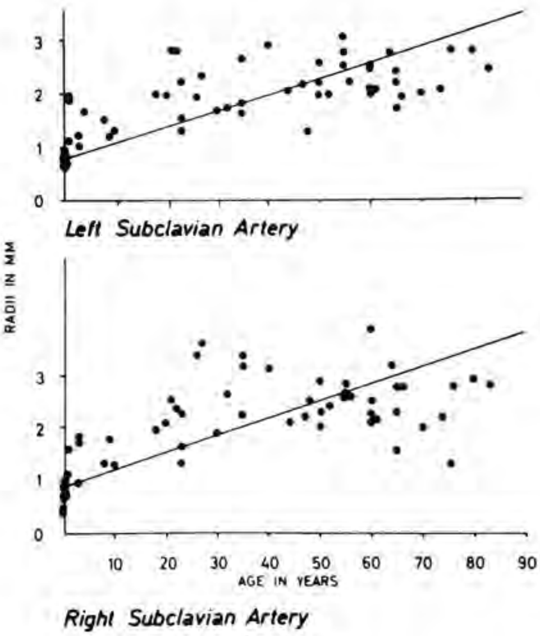

Fig. 1
Right and left subclavian artery.

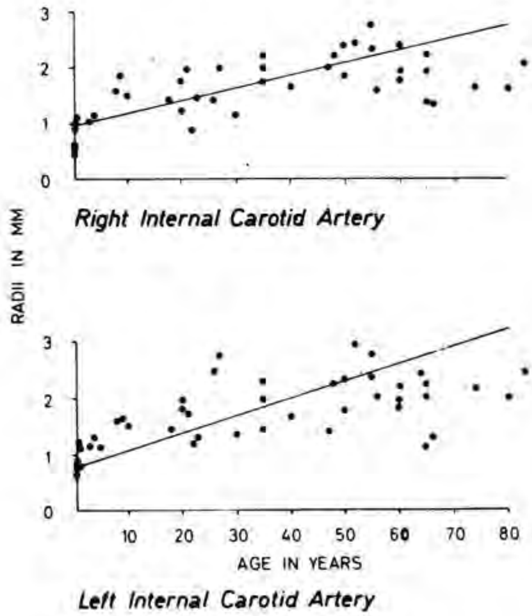

Fig. 2
Right and left internal carotid artery.

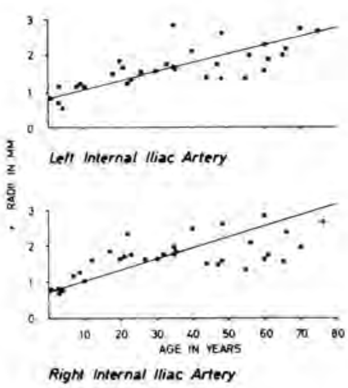

Fig. 3
Right and left internal iliac artery.

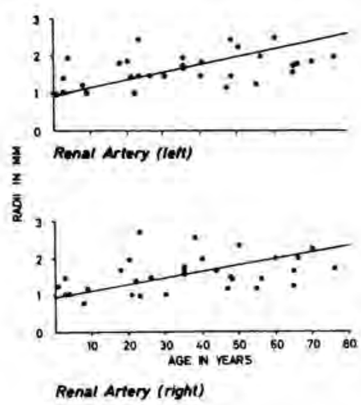

Fig. 4
Right and left renal artery.

that there is a gradual increase in the radii of these arteries with ageing.

Discussions

Some work on the internal radii of arteries has been documented in the literature. Elastic arteries dilate; small muscular arteries and arterioles contract. But nothing much has been recorded about the medium-sized muscular arteries. This study is mainly based on them.

Normally, when not contracted, arteries have a fairly uniform and smooth inner margin. Fig. 6. (Van Citters, et al 1962; Hayes, 1967; and Ham, 1967). But this margin is thrown into wavy folds when they contract. (Fig. 7). If this wavy border can be traced and measured with a suitable instrument after proper magnification, the real circumference and the radius of an artery can be calculated. This will give the true measurement of the arteries when the owners of these arteries were alive, even though

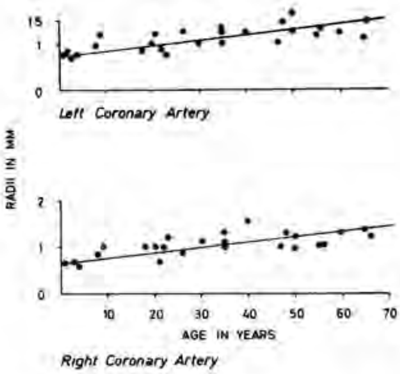

Fig. 5
Right and left coronary artery.

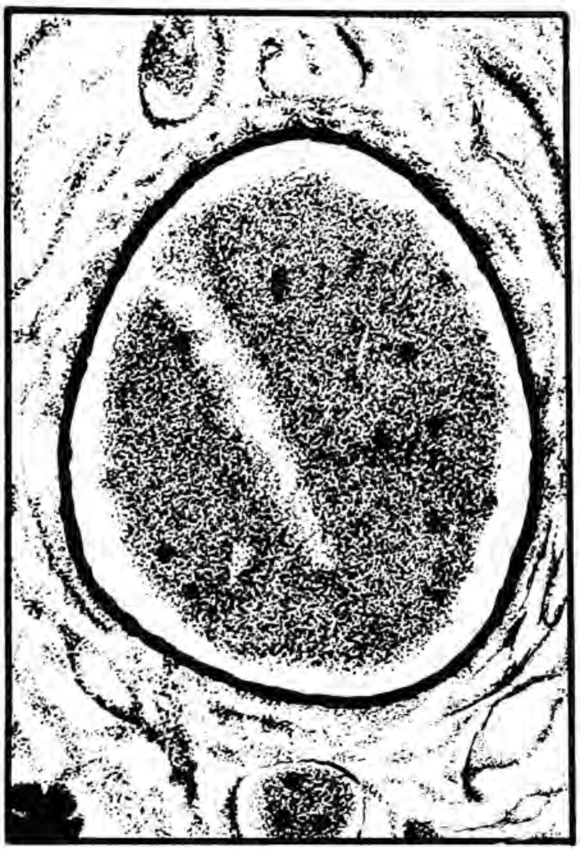

Fig. 6
Diagram showing uniform inner circumferential margin of an artery when not contracted.

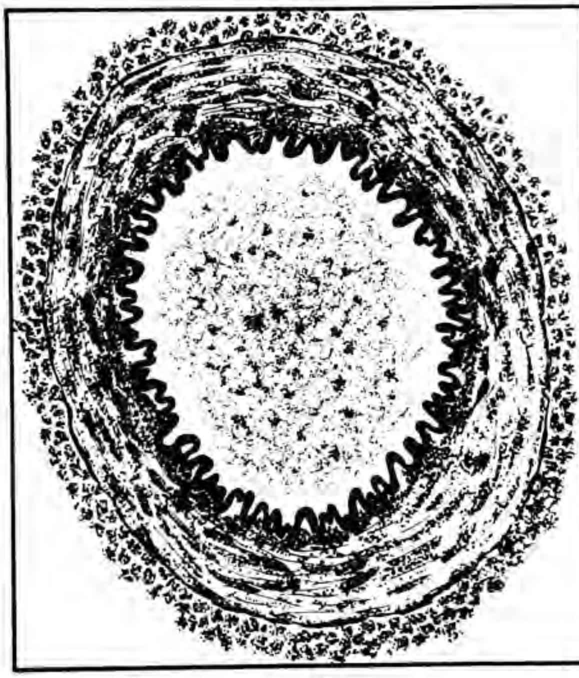

Fig. 7
Diagram showing the wavy inner circumferential margin of an artery when contracted.

these measurements have been obtained from their cadavers. This has already been mentioned in this paper.

Elastic arteries

That the radii of elastic arteries enlarge with age has been universally accepted. In this investigation, a few exceptions are observed, but on the whole, these arteries have shown a gradual enlargement of their internal radii with advancing age. The thirtieth year is considered to be the maximal age of developmental maturity in man. (Blumenthal, 1954 & 1967). This increase in radii is attributed to the following factors, viz; fragmentation of elastic lamina, increased fibrosis of arterial wall, its rigidity with loss of elasticity and the proportional rise of blood pressure during old age. (McDonald, 1960; Bourne, 1961; Bard, 1961; Levine, 1964; Ahmed, 1967; Lansing, 1969). This condition of widening is named "senile ectasia" of arteries according to Aschoff. In this present study, it is confirmed once more.

Muscular arteries (medium-sized)

It has been proved that smaller muscular arteries and arterioles are narrowed down with age. This is one of the reasons of raised blood pressure in old age and subsequent dilatation of elastic arteries. As regard medium-sized arteries, nothing definite has been proved.

In this investigation, it has been noticed that these arteries also manifest similar widening of their lumen-like elastic arteries. This finding agrees with those found by Dibble (1966) and Abramson (1967), but differs with Roach and Burton (1969) who found narrowing of the lumen of these muscular arteries. All the factors that are responsible for the enlargement of the lumen of elastic arteries in old age are found in the walls of these muscular arteries with ageing. In addition to these changes, there are defects in the neuromuscular junctions in the arterial walls. The general weakness of muscle due to old age may also be considered another additional factor. (Pareira, et al 1953; Lansing, 1959; McDonald, 1960; Comfort, 1965; Lavine, 1964; Learoyd, et al 1966; Ahmed, 1967; and Robins, 1967).

From the above explanations, it is quite reasonable to conclude that the radii of these arteries should also have identical changes like those of elastic arteries. We found it in our present observations.

An analogy may be drawn between the consistency of an arterial wall and that of an India-rubber tube. In a new piece of such tube, if inflated, the pressure inside it will distend its wall and make its calibre bigger. When the pressure is released its wall will recoil and regain its original calibre. But the same thing when "old" and stiff will not do so even after the withdrawal of the distending force. (Bard, 1961). A comparable phenomenon takes place in an arterial segment. Though an artery is not an inert structure like India-rubber yet with advancing age, physical and biochemical changes in the elastic and muscular tissues of its wall will make it firm and rigid with loss of elasticity.

Arterial calibres are controlled by various factors. Everything remaining normal, there is always a longitudinal and lateral expansion of the arterial walls during a cardiac systole. (Gould, 1968). As age advances, the changes produced in the arterial walls (already mentioned) will produce a compensatory rise in blood pressure. During this phase of life, the expansion of the arterial walls with each cardiac systole, however negligible it may be, will never recoil back to its pre-existing shape. This being continued, there is every reason to believe that the radii of these arteries will increase in size. The medium-sized arteries should not be an exception.

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Summary

An investigation on the arteries of 50 cadavers of different ages has been done to compare the variations of their internal radii with ageing. A gradual increase in them is observed in both elastic and muscular arteries. A simple method for measuring the radii of these arteries has been described and the author's opinion is submitted.

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