

## THE COLLAGEN CONTENT OF THE NORMAL AND ATHEROSCLEROTIC HUMAN AORTIC INTIMA

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Received for publication February 5, 1962

At birth, the human aortic intima consists of a single layer of endothelial cells with some underlying ground substance, and with ageing the intima gradually thickens, an occurrence which must profoundly affect its mechanical and physiological functions. The following brief study is an attempt to quantitate chemically one of the more specific tissue elements, collagen, in the normal and atherosclerotic intima.

It appears that the normal intima does contain collagen and that the amount is increased in the hyaline plaque characteristic of atherosclerosis; sex variation was not found to occur.

### METHODS AND MATERIALS

Human aortae were obtained fresh from 101 unselected post-mortems; they were pinned out and with the dissecting microscope suitable areas demarcated and the normal intima gently dissected away from the media with fine forceps; histological controls were taken from each area before and after dissection as a check that the media had been left intact. After formalin fixation and wax embedding, sections were stained with haematoxylin and eosin, Van Gieson's stain and Weigert's stain for elastic. Where possible, hyaline plaques free of ulceration, calcification and obvious fat deposits were similarly collected for analysis and histology.

The fresh specimens were desiccated in an Abderhalden drying apparatus, and about 10 mg. of the dried material hydrolysed for 3 hr. in a sealed tube with 1 ml. of 6N HCl at 140° in an oil bath, the hydrolysate being made up to volume with water. The collagen content was analysed by assaying the hydrolysate for hydroxyproline, an amino acid which is virtually specific in the bound form to collagen of which protein it forms 14 per cent dry weight. The method used was a modification of that of Neuman and Logan (1950), the specimens being examined in duplicate with the addition of a third tube to which no peroxide had been added in order to estimate background chromogens (Gallop, personal communication).

### RESULTS

The collagen content of the normal intima increases only very slightly with age (Fig. and Table I); the collagen content of the hyaline plaque also increases slightly with age and is on the average 50 per cent greater in amount than that of the normal intima (Fig. and Table I).

In both cases there appears to be no sex differences (Table II).

### DISCUSSION

The data presented illustrate one of the responses of the normal aorta to the ageing process; the deposition within the intima of a non-elastic material such as collagen must alter the mechanical and physiological behaviour of the aorta.

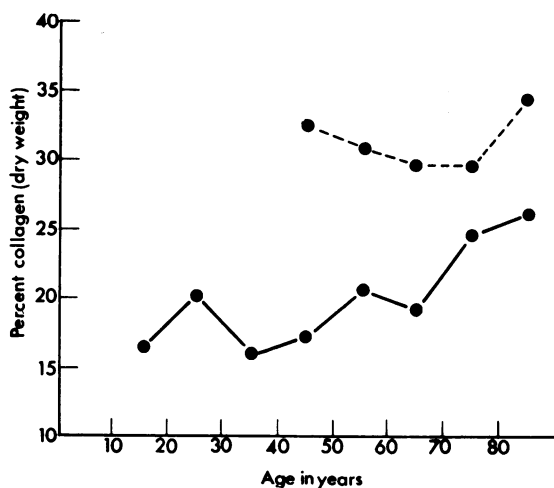


FIG.—Collagen content at various ages.

●——● Normal intima.  
●- - -● Intimal hyaline plaque.

TABLE I.—Collagen Content at Various Ages

| Age (yr.) | Normal intima              |  |                                  | Hyaline intimal plaques    |  |                                  |
|-----------|----------------------------|--|----------------------------------|----------------------------|--|----------------------------------|
|           | Number of samples analysed | Mean value in g. collagen per cent (dry wt.) | Standard deviation of mean value | Number of samples analysed | Mean value in g. collagen per cent (dry wt.) | Standard deviation of mean value |
| 0-10      | —                          | —  | —                                | —                          | —  | —                                |
| 11-20     | 8                          | 16.45  | ±1.54                            | —                          | —  | —                                |
| 21-30     | 5                          | 20.30  | ±1.40                            | —                          | —  | —                                |
| 31-40     | 5                          | 15.96  | ±1.40                            | —                          | —  | —                                |
| 41-50     | 7                          | 17.36  | ±0.98                            | 2                          | 32.48  | ±0                               |
| 51-60     | 11                         | 20.72  | ±1.75                            | 7                          | 30.94  | ±3.29                            |
| 61-70     | 13                         | 19.18  | ±1.12                            | 12                         | 29.61  | ±2.68                            |
| 71-80     | 7                          | 24.64  | ±2.45                            | 12                         | 29.68  | ±2.03                            |
| 81-90     | 2                          | 26.11  | ±4.90                            | 9                          | 34.44  | ±2.59                            |

TABLE II.—Collagen Content in Males and Females

| Sex    | Normal intima          |   |                                  | Hyaline intimal plaques |   |                                  |
|--------|------------------------|---|----------------------------------|-------------------------|---|----------------------------------|
|        | Number of observations | Mean value g. collagen per cent (dry wt.) | Standard deviation of mean value | Number of observations  | Mean value g. collagen per cent (dry wt.) | Standard deviation of mean value |
| Male   | 29                     | 19.90                                     | ±0.84                            | 23                      | 31.57                                     | ±1.61                            |
| Female | 29                     | 19.75                                     | ±1.12                            | 20                      | 30.36                                     | ±1.61                            |

It is interesting that the majority of the collagen destined to be laid down in the normal intima, already appears during the second decade, suggesting perhaps a physiological rather than pathological process.

One possible explanation of the increased collagen content of the plaque may be its increased thickness and concomitant vascular and nutritional disturbance (Geiringer, 1951). It is regrettable that the lack of adequate specific chemical criteria prevent the chemical identification of the numerous other protein components of intima and plaque.

#### SUMMARY

Samples of 101 normal and atherosclerotic human aortic intima were analysed for collagen content. The normal intima contained an average of about 20 per cent (dry weight) and the hyaline plaques an average of about 31 per cent ; there was a slight increase with ageing ; no sex differences were observed.

The authors gratefully acknowledge the advice of Professor Sir Howard Florey, P.R.S. ; the help of Dr. A. H. T. Robb-Smith and colleagues and of Mr. Harold Wheal in the collection of material ; and of Miss Christine Court and Mr. Stanley Buckingham for the reproduction of the Figure. Histological sections were prepared by Frl. Rose Niederberger.

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