COMPARATIVE STUDY OF THE ELASTIC TISSUE IN AXILLARY AND FEMORAL ARTERIES OF HUMAN FOETUSES

H. N. ALLAM, R. ZAAFARANY AND B.F. AHMED

Anatomy Department of the Islamic Faculty of Girls.

INTRODUCTION

The present investigation is a comparative study on the development of elastic lamellae of the femoral and axillary arteries in the human fœtuses. It included morphological study, micrometric methods dealing with the number, thickness and distensibility of the elastic tissue of both arteries.

The selective staining of elastic lamellae of the blood vessels was first achieved by weigert (1898) who introduced resorcine fochsin method. In addition Tanzer's orcein stain (Tanzer, 1891) had become one of the most famous techniques to define the elastic tissue.

Balo (1963) called some arteries like aorta innominate, common carotid, subclavian and its branches and the hypogastric arteries as elastic arteries since they have a large amount of elastic fibres. According to Carleton (1945), the middle coat of large arteries is the site of development of elastic tissue. The tunica media contains circular, discontinuous, fenestrated elastic membranes (Ham, 1957; Abou-El-Naga, 1963 and Tarkhan, 1965).

Some workers counted the number of elastic lamellae in the aorta (Arey, 1963; Bolo, 1963 and Maximow and Bloom, 1957). Others studied the histogenesis of the elastic lamellae like Hueck (1920), Krompecher (1930 & 1931), Hall *et al* (1952) and Gross (1949 and 1951).

MATERIAL AND METHODS

Ten human fœtuses were used in this study, two from each of the following age groups, 145 days, 160 days, 171 days, 233 days and 280 days.

The human fœtuses were obtained from obstetric hospitals and fixed immediately by abdominal and subcutaneous injection of 10% formalin. The ages were calculated ac-

Egypt. J. Anat., Vol. 2, 95 - 104, (1979).

cording to the crown - rump length. After proper fixation, the specimens were dehydrated in ascending grades of alcohol, cleared in benzene then embedded in paraffin and serial transverse sections 10*u* thick thick were obtained. The sections were stained with Tanzer Unna acid orcein (Lillie, 1953).

Quantitative estimation :

A cross line disc and a micrometer were used. The cross line disc was used to divide the blood vessel into four quadrants. Its lines cross the blood vessels into four points. At these four points calculation of the number and measurments of the thickness of elastic lamellae had been done. The points of intersections were adjusted to coincide with the wall of the blood vessel, midway between the outer and inner circumference. The calculation of the number of elastic lamellae and measurments of their thickness was performed using a magnification of 1000 (oil immersion lens x 100 and ocular lens x 10).

Calculation of the crimp percentage :—

The crimp percentage explains the degree of waviness of a certain long fiber occupying a distance shorter than its straight length. It was calculated according to Pierce's formula (Pierce, 1937).

$$\text{Crimp percentage} = \frac{D_s - L_c}{L_c} \times 100$$

where :

L_s = The straight length of the wavy or crimped lamella after being straightened. L_s was obtained by using a curvimeter.

L_c = The length occupied by the wavy fibers.

RESULTS

Histogenesis :

In young foetuses aged 145, 160 days, the elastic lamellae were short, nearly straight and separated by rows of elastoblasts (Figs. 1 to 4). The elastoblasts weer adherent to the elastic lamellae. The wall of the axillary artery was not only thicker from the beginning but also was more rich in elastic lamellae than the femoral artery (Figs. 1 to 4).

At the outer side of the elastic lamellae, there was a thick zone of crowded elastoblasts in both arteries. Still further there was a layer of undifferentiated mesenchymal cells (Figs. 1 to 4).

As age advanced, the elastic lamellae increased in number, thickness and waviness in both arteries (Figs, 5 to 8). The affinity to take up orcein stain also increased with advancing age in both arteries (Figs. 1 to 8).

Internal elastic lamella :

As a rule the internal elastic lamella was found to be continuous, thicker, and more wavy than the other elastic lamellae in both axillary and femoral arteries (Figs. 2, 3, 5 & 8).

In the fœtus aged 145 days, the internal elastic lamella was the first to be formed. In the femoral artery it was mostly, the only elastic lamella found at that age (Fig. 1). However in the corresponding age, the internal elastic lamella of the axillary artery was surrounded by additional 4-5 elastic lamella (Fig. 2). As the fœtus became older the internal elastic lamella of the axillary artery was always found to be thicker and more wavy than that of the femoral artery (Figs. 6 & 8). Moreover, it was found that in both arteries, there was always a space between the internal elastic lamella and the lamellae next to it; this was occupied by islands of smooth muscle fibres.

NUMBER OF ELASTIC LAMELLAE

The number of elastic lamellae was obtained in various ages from the maximal number which could be counted equally at the four fixed points chosen for calculation of the number and thickness of elastic lamellae.

The data obtained for the number of elastic lamellae were reported in table (I). From this table it is clear that in the young fœtus aged 145 days, the axillary artery had more elastic lamellae than the femoral artery. In the next ages from 160 days to 280 days old fœtus, there was a steady and progressive increase in the number of elastic lamellae in both axillary and femoral arteries. But it was noticed that the rate of increase in the number of elastic lamellae is greater in the femoral artery than in the axillary artery, since it was observed that in the full term fœtus, the elastic lamellae had increased three times in the axillary artery and six times in the femoral artery.

Table (1) shows the number of elastic lamellae in axillary and femoral arteries

Age in days	Number of elastic lamellae	
	Femoral artery	Axillary artery
145	1 — 2	5
160	4	9
171	5	11
233	7	12
280	12	15

THICKNES OF ELASTIC LAMELLAE :

The average thickness in microns of the elastic lamellae in sections of axillary and femoral arteries in difrenent ages were reported in table (II). This table shows that the average thickness for all elastic lamellae in both arteries increased progressively from the age of 145 days fœtus until full term but the thickness increased twice in the axillary artery and thrice in the femoral artery.

Table (II) Shows the thickness of elastic lamellae in axillary and and Femoral arteries.

Age in days	Thickness of elastic lamellae (in microns)	
	Femoral artery	Axillary artery
145	0.55	0.84
160	0.60	0.94
171	0.97	0.97
233	1.03	1.03
280	1.71	1.71

CRIMP PERCENTAGE :

An elastic lamella from the middle of the tunica media was chosen for these measurements in both femoral and axillary arteries. The average length of the lamella in cm. per 10 cm. segment of the circumference of axillary and femoral arteries was calculated. The results for the crimp percentage were shown in table (III). The crimp percentage is taken as an index for the degree of waviness of elastic lamellae.

Table (III) : shows the crimp percentage of elastic lamellae in the axillary and femoral arteries.

Age in days	Crimp % of elastic lamellae	
	Femoral artery	Axillary artery
145	9 %	13 %
160	10 %	14 %
171	11 %	15 %
233	14 %	19 %
280	31 %	36 %

This table shows that the elastic lamellae are more wavy in the axillary artery than in the femoral artery in young fœtuses. As the age of the fœtus increased the degree of waviness increased greatly in both arteries and was still slightly greater in the axillary artery than in the femoral artery of a full term fœtus.

DISCUSSION

Extensive studies were made on the elastic tissue of blood vessels in general and the aorta in particular (Hueck, 1920; Gross, 1949 & 1951 and Lansing, 1952). Most of these studies had dealt with the chemical structure of the leastic lamellae, the histogenesis of the blood vessels and the effect of age. The present work which is a comparative study of the development and morphogenesis of elastic tissue in the axillary and femoral arteries in human fœtuses is probably performed for the first time.

In the present work, the increased staining affinity of the elastic lamellae for orcein in the older ages might be explained by an increase in the amount of mucopolysaccharide content of elastic tissue as the fœtus became older (Gromori, 1950; Scott and Clayton, 1953). It might also be explained by the increased carboxyl group in the elastin of axillary and femoral arteries as age advanced (Lansing *et al*, 1951).

HISTOGENESIS OF THE ELASTIC LAMELLA :

In the present investigation, the contact of elstoblasts with the developing elastic lamellae might be a proof that they took part in the production of elastic substance. According to krompecher (1930 & 1931), the elastoblasts which probably resulted from undifferentiated mesenchymal cells produced the elastic scubstance in the form of fine pericellular membrane. Dempsey and Lansing (1954) reported that the elastic fibres were formed extracellularly by condensation outside the cells of precursers located in the intercellular substance. On the other hand, Hueck (1920) mentioned that the elastic fibers were produced by the infiltration of the network with elastin.

NUMBER OF ELASTIC LAMELLAE :

In young fœtus aged 145 days, it was found that the axillary artery was more rich in elastic lamellae (5 lamellae) than the femoral artery (1 - 2 lamellae). This might be due to the rapid development of the upper limb than the lower limb during the first half of fœtal life. But in the second half of fœtal life, the development of the upper limb probably proceeds at a slower rate than the lower limb since the elastic lamellae increased only three times in the axillary artery and six times in the femoral artery.

The abundance of elastic tissue in the axillary than the femoral artery might be due to the large volume and higher tension of blood pumped in it to supply the more rapidly developing upper limb. In addition the high tension in the axillary artery could be attributed to the fact that it is much nearer to the left ventricle than the femoral artery.

Generally the increase in the number of elastic lamellae in both axillary and femoral arteries follow the increase in the blood pressure of the fœtus. Actually all the tissues of the wall of the blood vessels i.e. the endotheial lining, the elastic fibres, the collagenous tissue and the smooth muscle contribute to its total tension (Burton, 1954).

In the present study the crimp percentage, was taken as an index for the degree of extensibility of the elastic lamellae and distension of the blood vessels. Accordingly, the greater waviness of the elastic lamellae in the axillary artery than in the femoral artery might allow the axillary artery to be more distensible than the femoral artery to supply the more rapidly growing upper limb.

INTERNAL ELASTIC LAMELLA :

In the femoral artery the internal elastic lamella was always found at the age of 145 days old fœtus. Sometimes, it was followed by another layer of elastic lamella. But, in the axillary artery of the fœtus of the same age, the internal elastic lamella was always surrounded by 4 - 5 layers of elastic lamellae.

This might be a proof that the internal elastic lamella was the first to be formed in both arteries, then it was followed by the formation of the other elastic lamellae. This means that, building up of the wall of both arteries probably occured from inside outwards.

In the present work the internal elastic lamella was always found thicker and more wavy in the axillary than the femoral artery. This might also be due to the higher tension of blood in the axillary than in the femoral artery.

SUMMARY

Ten human foetuses were used in this study; two from each of the following ages : 145 hays, 160 days, 171 days, 233 days and 280 days. The femoral and axillary arteries were exposed and excised in each specimen. They were fixeh in formalin, washed, dehydrated, cleared and embedded in paraffin wax. Then they were cut into sections 10 microns thick. The sections were stained with orcein.

It was found that the elastic lamellae were developed from inside outwards; the first lamella to appear was the internal elastic lamella. These elastic lamellae were produced by elastoblasts. After maturation of the elastic lamellae, the elastoblasts were observed to change to fibrocytes. Maturation of elastic lamellae was indicated by their increased affinity

for orcein and by the increase in their thickness and waviness.

The number of elastic lamellae increased three times in the axillary artery and six times in the femoral artery. Their thickness increased steadily from 125 days until full term in both arteries. The degree of waviness was always higher in the axillary than in the femoral artery by 5%. There was also a steady increase in the crimp percentage of both arteries until full term.

REFERENCES

1. **Abou-El-Naga, I.** : Histology for medical students, Anglo-Egyptian Bookshop, Cairo. P. 150 (1963).

2. **Arey, L.B.** : Human Histology. Saunders Company, philadelphia and London. P. 127. (1963).

3. **Balo, J.** : Int. Rev. of connective Tissue Research, Edited by David A. Hall, Academic Press- New York to function of the tissue of the wall and London, **I.** : 263 - 264. (1963).

4. **Burton, A.C.** : Relation of structure of blood vessels. Physiol. Rev., **34** : 219 - 242. (1954).

5: **Carleton, H. M.** Schafer's Essentials of Histology. Longmans, Green and Co. London. New York. Toranto., PP. 215 - 217 (1945).

6. **Dempsey, E. W. and Lansing, A. I.** : Elastic tissue. Int. Rev. Cytol.- **3** : 437. (1954).

7. **Gromori G.** : Aldehyde - Fuchsin : A New stain for Elastic tissue. Am. J. Clin. Path., **20** : 665. (1950).

8. **Gross J.** : The structure of elastic tissue as studied with the electron microscope. J. Exptl. Med., **89** : 699. (1949).

9. ....: Fiber formation in Trypsinogen solutions : An electron optical study. Proc. Soc. Exptl. Biol. and Med., **78** : 241. (1951).

10. **Hall, D.A.; Reed, R. and Tunbridge, R.E.** : Structure of elastic tissue. Nature **Mo** : 264. (1952) .

11. **Ham, A.W.** : Histology. J.B. Lippincott Company philadelphia and Monterial. P. 585. (1957).

12. **Hueck, W.** : Muench. Med, wochschr. **67** : 535. (Cited by Balo, j. 1963, Int. Rev. of connective tissue research, **I** : 263 - 264 (1920).

13. **Krompecher, St.** : Beitr. Pathol., Anat. Allgem. pathol. **85** : 647. (Cited by Balo, j. 1963, Int. Rev. of connective tissue Research, Vol. I. : 263 - 264). (1930).

14. ....: Anat. Anz. (Erg. H.) 71. 49. (Cited by Balo 1973, Int. Vol. I. : 263 - 264 (1931).

15. **Lansing, A.I.** : The rule of elastic tissue in the formation of the arteriosclerotic lesion. Ann. Internal. Medicine, **36** : 39 (1952).

16. **Lansing, A.I.; Roberts, E.; Ramsarma, G., B.: Rosenthal T.B. and Alex, M.** : Changes with age in aminoacid composition of arterial elastin. Proc. soc. Explt. Biol. and Med., 76 : 714. (1951).

17. **Lillie, R.D.** : Histopathologic technique and practical histochemistry, the Blakiston Company. INC. New York, Toronto. P. 360 (1953).

18. **Maximow, A, A. and Bloom, W.** : A. Textbook of Histology. Sounders company. Philadelphia and London. P. 237 (1957) .

19. **Pierce F.T.** : Geometry of the plain woven fabric. Journal of textile Institute. **28** : 45. (1937).

20. **Scott, H. R. and Clayton, B. P.** : A comparison of the staining affinities of Aldehyde-Fuchsin and the Schiff Reagent. J. Histol. and cytochem. **1** : 336. (1953).

21. **Tanzer, P.** : Manatscher. prakt. Dermatel. 12, 394. (Cited by Dempsey and Dansing 1954, Int. Rev. Cytol. 3 : 437. (1891).

22. **Tarkhan, A.A.** : Hand book of histology. Costa Thoumas and Co.- Press Cairo. P. 138. (1965).

23. **Weigert, C.** Zentr. Allgem. Pathol. U. Pathol Anat. 9 : 287. (Cited by Dempsey and Lansing 1954, Int. Rev. Cytol. **3** : 437 (1898).

LEGENDS

Fig. (1) : Transverse section in the femoral artery of a human foetus aged 145 days. **(Orcein - x 850)**

Fig. (2) : Transverse section in the axillary artery of a human foetus aged 145 days. (Orcein - x 850)

Fig. (3) Transverse section in the femoral artery of a human foetus aged 160 days. (Orcein - x 850)

Fig. (4) Transverse section in the axillary artery of a human foetus aged 160 days. (Orcein - x 850)

Fig. (5) : Transverse section in the femoral artery of a human foetus aged 233 days showing the elastic lamellae. (Orcein - x 850)

Fig. (6) : Transverse section in the axillary artery of a human foetus aged 233 days.

(Orcein - x 850)

Fig. (7) : Transverse section in the femoral artery of a human foetus aged 280 days showing internal elastic lamella (I) and elastic lamella (E).

(Orcein - x 850)

Fig. (8) : Transverse section in the axillary artery of a human foetus aged 280 days showing the elastic lamellae.

(Orcein - x 850)

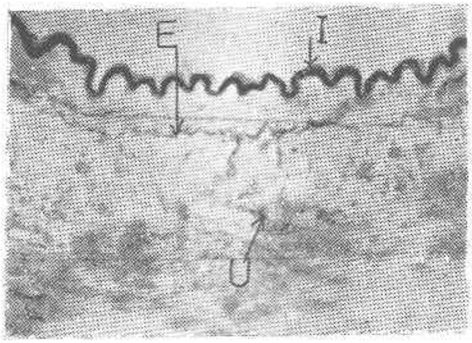

Fig. (1)

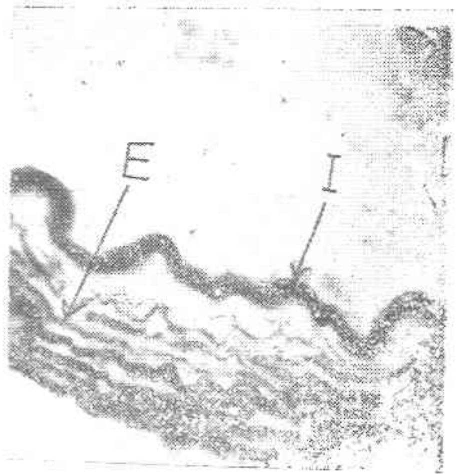

Fig. (2)

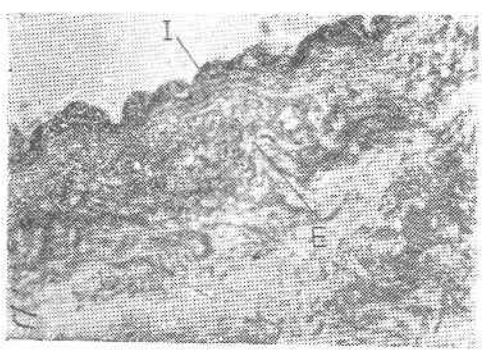

Fig. (3)

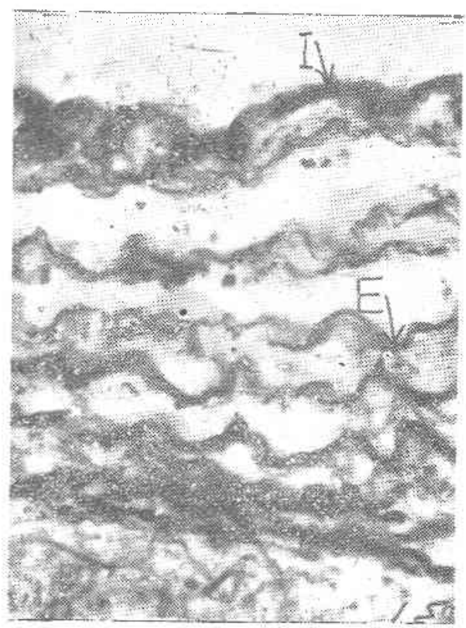

Fig. (4)

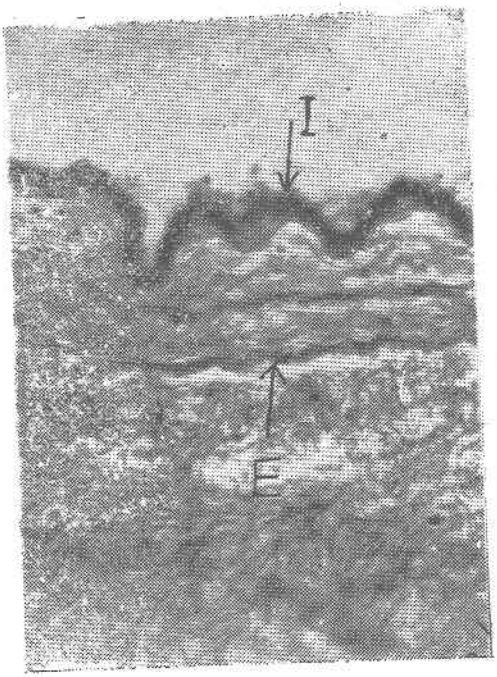

Fig. (5)

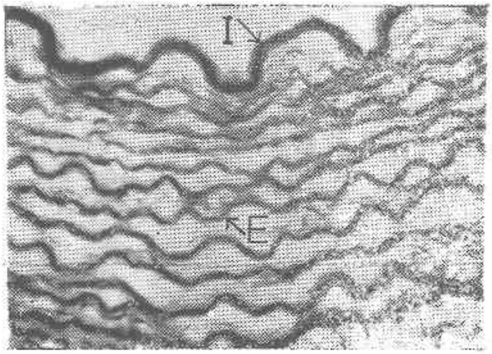

Fig. (6)

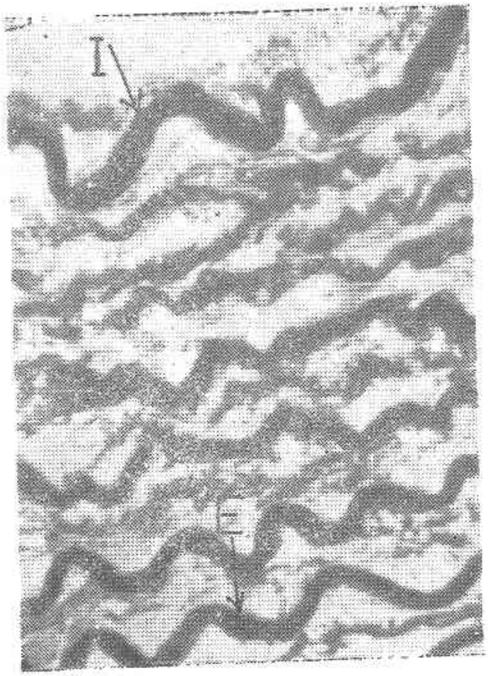

Fig. (7)

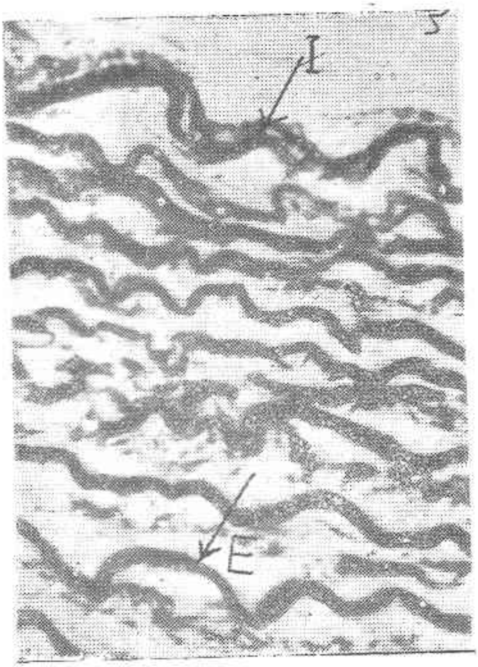

Fig. (8)