ALTERATIONS OF THE INTERNAL ELASTIC MEMBRANE IN THE COELIAC TRUNK AND ITS BRANCHES

HELmut SINZINGER, WALTER FEIGL, CHRISTIAN LEITHNER, GUNT RAM SCHERNTHANER, AND WERNER ERD

For a long time the opinion was held that changes of the internal elastic membrane (IEM) were of essential importance in early development of atherosclerosis. Lesions such as the discontinuity (Lindsay and Chalkoff 1963) or the reparable transformation have been found in very early periods of life (Wolff 1930, Vlodaver et al. 1969, Neufeld 1974 and others). Frankel (1965) demonstrated these alterations in neonates and foetuses. Neufeld et al. (1962) found out that such changes were statistically significant just at those localizations, where atherosclerotic alterations developed rather early and markedly in later periods of life. Similar lesions were observed in several mammals (Berg 1965, Lindsay and Chalkoff 1963, Neumann et al. 1970). Because of the early appearance of the symptoms the question whether it was pathological or a natural manifestation of aging had often been discussed (McGill 1974, Marchand 1904, Friedmann 1968). Many authors declared (compare literature in Velican 1974), that those primary alterations of the IEM together with senile changes of its chemical structure encouraged subsequently fatty infiltrations (Adams 1959, Velican 1975). Apart from the investigations of Velican and Velican (1974), reports with quantitative datamaterial did not exist. Therefore we studied the IEM of the coeliac trunk and its branches in four age groups using eight criteria. We were particularly interested, if the different kinds of alterations were correlated with age and/or atherosclerotic lesions.

MATERIAL AND METHODS

We examined the IEM of the coeliac trunk (CT) and its branches, splenic artery (SA), left gastric artery (GA) and common hepatic artery (HA), in 30 human beings (15 d, 15 r). The vessels were taken from autopsy material within ten hours after death. The samples were fixed in Burckhardt's solution or in 5% buffered formalin (pH 7.4) and embedded in paraffin. 7 μ sections were stained with HE, van Gieson's elastic, PAS and van Kossa. In each individual we evaluated at least 15 sections of each vessel. The following eight criteria, described by Velican et al. (1973), were used for evaluation.

1. Loss of regular undulation
2. Local swelling
3. Irregularity
4. Areas of granularity
5. Fragmentation
6. Fragmentation
7. Interruption
8. Reduplication

We examined the following number of individuals belonging to four age groups:

A  0 - 20 years (10 cases, 5 d, 5 r)
B  21 - 40 years (8 cases, 4 d, 4 r)
C  41 - 60 years (6 cases, 3 d, 3 r)
D  over 60 years (6 cases, 3 d, 3 r)

OBSERVATIONS

All alterations of the IEM were most distinct in the CT of all age groups. We observed very small differences in per cent only concerning changes in the arteries of age group A (compare figure 1 and 5). These differences increased up to 15 - 20% in the following age groups (figures 2-4). The most prominent alterations of the IEM of age group A were found in the HA. In the

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other age groups statistically significant differences between the CT and its branches did not exist.

When examining the various kinds of lesions we could observe, that loss of the regular undulation and the reduplication were dominant in the CT in all age groups (see figure 5). Lysis was more prominent in the GA of group A and B, while the reduplication dominated in C and D (see figure 6). In the SA and HA (see figure 7), prominent alterations could be seen with advancing age. In the last age group the reduplication dominated.

Statistically each of the eight alterations examined increased significantly from one age group to the next except in three cases (see figures 5, 6, 7 and 8). Lysis could be observed very early and hardly increasing with age. Similar was the occurrence of granular areas. The increase of some alterations differed considerably in the arteries. For instance the number of fragmentation increased in the CT from group A to B to the threefold, in the other three arteries however about a little more than 50%.

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The incidence of local swellings was of particular interest. It was uniform in the CT and in the GA. There we found a relatively small occurrence in per cent (see figure 5 and 6). We observed a flat course of the curve in th HA (see figure 8). In the splenic artery we found a similar behaviour as in the hepatic artery of age group A. On the other hand, the increase of the “localized swelling” in per cent was extremely high in the splenic artery of the older age groups. This was documented in figure 7 by a marked oscillation to the opposite side. On an average all changes of the IEM were more distinct found in females than in males, these differences were, however, statistically not significant. A particular preponderance of one distinct lesions could not be observed in either sex.

**DISCUSSION**

A splitting of the IEM occurs in several human arteries to a small degree soon after this membrane is completely developed, a stage reached in the fourth foetal month (Franke 1965). This splitting increases continuously with age. Wolff (1930) found this phenomenon in many arteries of neonates. It occurred more distinctly in those arteries, where atherosclerotic changes had already manifested themselves to a higher degree.

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**Fig. 3.** Condition of the internal elastic membrane in age group C. (41–60 years). Symbols as in figure 1.

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**Fig. 4.** Internal elastic membrane of individuals, aged over 60 years. Symbols as in figure 1.
Fig. 5. Comparison of the incidence of the 8 different lesions in the coeliac trunk of the 4 age groups. --- group A, --- group B, --- group C, and --- group D.

Fig. 6. Frequency of changes in the left gastric artery in per cent. Same symbols as in figure 5.

Fig. 7. Internal elastic membrane of the splenic artery in the four age groups. Notice the insignificant difference concerning criteria 4.

Fig. 8. Condition of the internal elastic membrane of the common hepatic artery. Notice that the curves cross over in criteria 4. (group A, B) and 6 (group B, C). Symbols used as in figure 5.

Fig. 9. Survey of the coeliac trunk of a 24 year old man (cause of death: Mb. Hodgkin). The internal elastic membrane is altered throughout its length. The intima is markedly widened, staining HE.

Fig. 10. Section of the internal elastic membrane of the coeliac trunk. The patient was a 37 year old female (cause of death: cancer of the breast). There are interruptions, granular areas and local swellings.

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Fig. 11. Interruptions, reduplications and severe damages of the internal elastic membrane of the splenic artery. The patient was a 51 year old man (cause of death: bronchial cancer).

Fig. 12. Localized complete absence of the internal elastic membrane with gross changes in the surrounding areas. Several smooth muscle cells lie between media and intima. The patient was a 64 year old female (cause of death: myocardial infarction).

Alterations of the Internal Elastic Membrane

(Neufeld et al. 1962). The evidence for a direct relation between the splitting of the IEM and the development of atherosclerotic lesions remained, however, open. Velican and Velican (1974) found a marked splitting in the coronary arteries. 80% of these arteries were altered in the fourth decade of life. In further age groups these changes increased very little. 50% of the CT underwent a change in the fourth decade. In this artery, however, an increased involvement was markedly due to advancing age. We found the values of alterations in per cent nearly identical with those of the coronary arteries in the 7th and 8th decades. The degree of degenerative alterations of the IEM was noticeably lower in the GA, HA and SA. On the other hand, Hallenberger (1906) found these alterations in the radial artery at a very early date, but the percentage of these changes was unimportant. The value of local swellings in all the arteries of group A was distinctly low. In juveniles the arteries showed little change and the value of involvement was relatively low in proportion. Differences concerning the involvement of the arteries we examined were not significant. In the more advanced age groups the degree of local swellings in the IEM of all arteries examined, was obviously similar in value to the occurrence and extension of atherosclerotic complications in the same arteries. The SA (areas of granularity 44-56-60%) was the first in the sequence of involved arteries in grown ups (see detailed literature in Sinzinger et al. 1974). Then the HA (29-49-58%), the CT (27-39-57%) and at last the GA (19-28-31%) followed. Six of the used criteria correlated significantly with age. Contrary to it, the local swelling of the IEM correlated significantly with atherosclerotic involvement of the arteries we examined. These particular informations were not given by Velican and Velican (1974). The percentage concerning their values of involvement by fragmentations, lysis and interraption was similar to our results. The light microscopical lesions of the IEM need not necessarily correlate with those of the electron microscope. According to our results an estimation of the age of a known vessel is possible. This is of importance in routine histology and forensic medicine.

These morphological data are of particular importance not only for routine diagnostics, but also for the records regarding the changes of chemical structures, which correlate with the morphological ones in a characteristic way (Velican 1974). Lansing et al. (1951, 1955), Fitzpatrick et al. (1965) and Yu (1971) found a change in the amount of amino acids in the IEM. Haust and Geer (1970) observed an increased deposition of calcareous substances, while the greater deposition of fatty material was found by Zugibe et al. (1960, 1961), Adams (1959) and Kramsch et al. (1970, 1971). Meyer (1974) and Sinzinger et al. (1974) observed primary fatty infiltrations in infants and juveniles, particularly in the IEM. Later in life these infiltrations extend to surrounding areas, especially to the media. Kramsch et al. (1971) reported, that the contents of lipids in the split IEM were increased up to the twentyfold value and measured nearly 40%. Similar investigations with radioactive labelled substances are being performed. Robert et al. (1974) reported, that the morphological alterations of the IEM were caused by the secretion of elastase, which increases with age. Further investigations will be necessary to prove the findings and to examine the relation between morphological and chemical structures in detail.

SUMMARY

Changes in the internal elastic membrane of the coeliac trunk and its branches begin in the foetus. Usually these changes increase with advancing age. The intensity of involvement varies in different arteries, localized swelling is of particular importance as a measure of atherosclerotic involvement. There is a close relationship between morphology and chemical structure.

REFERENCES


