The Histologic Appraisal of Myocardial Lesion

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A quantitative description for histological observation of myocardial lesion was proposed. Left ventricle was divided into 25 divisions. Whole paraffin sections were made from each of them, and stained by haematoxylin-eosin and Azan method. The extent and kind of myocardial lesions of these samples were examined histologically.

The results of the examination were described by "myocardial lesion profile" (M.P.) which was theoretically similar to Gore's atherosclerotic profile, M.P. was changed to "myocardial lesion index" (M.I.) by a simple calculation.

It is possible to express the grade of pathologic changes of myocardium as a number of myocardial lesion index. The grades of the myocardial lesions could be compared quantitatively with those of other samples. The mean values of index in many cases can be also obtained. It was shown that the myocardial lesions of hypertensive hearts were much severer than those of non-hypertensive ones. The lesions of the former were severest at the upper ventricular septum near the aortic ostium; it might be the hemodynamic influences of blood pressure which becomes highest at the aortic ostium (Fig. 14).

There are various types of human myocardial lesion—acute, chronic, regressive or progressive. The grade of cardiac lesions depends upon the kinds and extent of these pathologic changes. The grade of myocardial lesion has been frequently expressed by the words, "slight", "severe" or "moderate", according to a visual impression. These expressions are personal, and would depend on the skill and impression of individual workers.

Our appraisal method of myocardial lesions will be introduced in this paper. It will be possible to compare quantitatively the grade of myocardial changes of various samples by this method.

METHODS

GORE and TEJADA proposed atherosclerotic profile (A.P.) and atherosclerotic index (A.I.) for the appraisal of arterial atherosclerotic changes. A.P. shows the extent and the kind of the pathologic changes. A.I. is the index which is changed from A.P. into the number from 0 to 100.

It should also be possible to introduce "profile" and "index" which are based on the histological observations of myocardial lesions.

Although there are many different types of pathologic changes of myocardium, all lesions of cardiac muscle fiber itself can be classified into next three pathologic categories.

1. simple hypertrophy (or atrophy)
2. degenerative changes
3. myocardial necrosis and disappearing of muscle fibers or fibrosis

Both hypertrophy and degeneration are often found in a muscle fibers; hypertrophic muscles may often show some kinds of degenerative changes. Experimentally induced cardiac hypertrophy of animal shows simple myocardial hypertrophy of muscle fibers at initial stage. Such a hypertrophic change is followed by a

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degenerative change. These muscles are gradually disappeared and are replaced by fibrosis. These three histological changes—simple hypertrophy, degeneration, necrosis or fibrosis—are not only the types, but also the pathological stages or grades (Fig. 1, 2, 3).

Gore and Tejada proposed the concept that the pathological changes progressed logarithmically; if we apply 1 for the early stage of the lesions, the second stage corresponds to 10 and the third stage should be 100. There may be some arguments about this hypothesis. But it seems to be impossible to find any other method which is better than that proposed by Gore and Tejada. If a simple hypertrophy is 1, the degeneration will be 10 and necrosis or fibrosis are 100. Most myocardial fibrosis is, however, partially fibrotic. The value “100”

Fig. 1. Simple hypertrophy of myocardium.

Fig. 2. Myocardial degeneration.
should be given to the complete fibrosis (or necrosis). The grade of partial fibrosis, for instance reticular fibrosis, should be considered by the amount of fibrous tissue occupying in fibrotic area.

Four stages of myocardial fibrosis (or necrosis) are differentiated according to the amount of remaining muscles among fibrous tissue.

i) complete fibrosis—remaining muscle fibers can not or almost can not be identified (Fig. 3) .......... (c)

ii) severe fibrosis—the number of myocardial muscles of fibrotic area is less than 1/3 of normal myocardium (Fig. 4) ........................................ (s)

iii) moderate fibrosis—remaining muscle fibers are among 1/3 ~ 2/3 of normal (Fig. 5).......................... (m)
iv) slight fibrosis—remaining muscle fibers are more than 2/3 of normal (Fig. 6)

................................. (1)

If the value 100 is applied to the complete fibrosis, severe fibrosis will be 80, moderate fibrosis will be 50 and slight one 20.

The description of the extent of the lesions, on the contrary to the grading, is simple. It can be expressed by the percentage of the pathologic area in a myocardial section.

Formalin-fixed left cardiac ventricle is cut into 5 round horizontal slices at width of about 1.5 cm. The slices are called respectively from the upper one, Section I, II, III, IV and V (Fig. 7).

Each section is divided into 5 divisions, the anterior wall, lateral wall, posterior wall, anterior half of the ventricular septum and

Fig. 5. Moderate fibrosis of cardiac muscle.

Fig. 6. Slight fibrosis of cardiac muscle.
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posterior half of it. From all of them, paraffin sections are made and stained by haematoxylin-eosin and Azan method for histologic study. So, 25 histologic sections can be obtained from one heart. Sometimes, if necessary, 3 subdivisions of each divisions, internal 1/3, middle 1/3, and external 1/3, are obtained (Fig. 8).

On examining these histologic sections, 6 grades are differentiated according to the extent of the lesions.

0 ...the lesion could be seen less than 10 per cent of the histologic sections
A ...the extent of the lesions is between 10 ~20 per cent
B ...the extent of the lesions is between 20 ~40 per cent
C ...the extent of the lesions is between 40 ~60 per cent
D ...the extent of the lesions is between 60 ~80 per cent
E ...the extent of the lesions is more than 80 per cent

Each grades are expressed by their average values of percentage; Grade 0 is expressed by 5, Grade A is by 15, B is 30, C ...50, D ...70 and E ...90. These figures are necessary to calculate the “myocardial lesion index”.

Myocardial lesion is classified into 3 types mentioned above; simple hypertrophy (or atrophy), degeneration, and fibrosis (or necrosis). If a division, for instance, shows grade C lesion consisted from 50 per cent of simple hypertrophy, 30 per cent of degeneration and 20 per cent of moderate fibrotic area, it may be written C_{532}^{m}, in which, 2^{m} means 20 per cent of moderate fibrosis. We call such inscription the “myocardial lesion profile”.

Thus, “the myocardial lesion profile”, for example “C_{532}^{m}”, can be changed to “myocardial lesion index” by following calculation.

C_{532}^{m} = 50 \times \left((5/10 \times 1) + (3/10 \times 10) + (2/10 \times 50)\right) = 675

In this equation, “50” represents Grade C (extension of the lesions occupying 40 ~60 per cent.

Fig. 7. Horizontal sections of cardiac wall.

Fig. 8. Five divisions on the horizontal section of left ventricular wall.

Fig. 9. Myocardial lesion indexes (M.I) on 25 divisions of macroscopically normal heart.
of whole area, and \("(5/10 \times 1)\", \"(3/10 \times 10)\" and \"(2/10 \times 50)\" represent first grade lesion (50\%), second grade lesion (30\%) and moderate fibrosis (20\%) respectively.

The description of the severest myocardial lesion profile (M.P.) is \(E_{00.0}^{10}\), and its index (M.I.) is

\[
E_{00.0}^{10} = 90 \times (10/10 \times 100) = 9000
\]

The number \"9000\" is inconvenient for practical use. It will be better to use \"100\", instead of \"9000\", as a highest value. Thus,

\[
E_{00.0}^{10} = 9000 \times 1/90 = 100
\]

and \[C_{552}^{10} = 675 \times 1/90 = 7.5\]

Three cases which were examined by our method will be introduced.

1. Fig. 9 is the heart from 34 years old female which does not show any heart disease macroscopically. Her M.I.s are very low (0.1 ~ 0.2).

2. Fig. 10 is the heart of 78 years old male. This case is also non-pathologic, but the M.I. of the upper part of ventricular septum reaches 6.2 because of his aging.

3. Fig. 11 shows the heart from uremic patient of 56 years old male. M.I.s of the upper ventricular septum are 16 or 18.

Ventricular papillary muscles were excluded in all cases because of their outstanding severe pathologic changes. The mean values of M.I.s of 7 cases of hypertensive hearts and 5 cases of non-hypertensive hearts on \"Section 2\" are shown in Fig. 12a and b. The thickness of the walls in those pictures indicates the severity of myocardial lesions and not the myocardial hypertrophy.

At a first glance, marked myocardial lesions on hypertensive hearts are realized. The lesion is the severest at the upper part of ventricular septum, especially posterior half of it, which is situated nearest to the aortic ostium.

This M.I. pattern may be reasonable for hypertensive heart, but may not always be true for other cardiac lesions originated from other diseases. The case in Fig. 13 is a hypertrophic heart with aortic stenoininsufficiency and mitral stenosis. The severest lesion exists near the apex of anterior ventricular wall.

Fig. 10. M.I.s of old man with normal heart. Upper part of the interventricular septum (Sect. I.) shows somewhat higher M.I.s.

Fig. 11. Hypertensive, hypertrophic hearts of a uremic patient reveals considerably high M.I.s, especially at the upper wall of interventricular septum.

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Fig. 12a. Average M.I.s of 5 cases of non-hypertensive "normal" hearts.

Fig. 12b. Average M.I.s of 7 cases of hypertensive hearts.

Fig. 13. M.I.s of the patient with valvular disease. M.I. pattern is different from that of hypertensives.

Fig. 14. Blood pressure becomes highest at the aortic valve where upper part of interventricular septum situates.

REFERENCES

Acknowledgement: Dr. Gore kindly advised us recently to divide the digit of fibrosis, necrosis into two digits; fibrosis and necrosis. It will be worthy enough to be considered. This time, however, we did not have such necrosis that had the areas recognizable as the other digit.

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