Angiographic Consideration of Rheumatic Mitral Valvular Disease

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An angiocardiographical analysis of the rheumatic mitral valvular changes was performed on 344 patients examined during the period from October, 1977 to July, 1980. The following results were obtained: 1) In the analysis of the mitral apparatus, the mitral orifice projection which enables us to observe the mitral annulus as en face and the long axial projection enabling us to observe the profile was particularly useful for the diagnostic validity. 2) Mitral orifice projection was useful for the diagnosis of stenosis dominant lesion, while long axial projection was beneficial for the diagnosis of regurgitation dominant lesion. 3) The measurements of mitral apparatus were carried out through these projection methods. It was found that the diameter of annular ring as well as the area of posterior leaflet were markedly increased in the mitral regurgitation group.

THERAPEUTIC advancement on heart diseases, particularly in the field of surgery, has been achieved during the past few years mainly due to the refinement of diagnostic modalities as well as the technical progress of surgical procedures. Therefore, as physicians engaging in diagnostic work, we must elucidate the details of the morphological changes before surgery. To obtain a fine morphological diagnosis by angiocardiology, we must have access to the subject concerned from the best possible angle. However, in conventional angiocardiographic study, most of the diagnoses have been made from the anteroposterior (AP), lateral, right anterior oblique (RAO) or left anterior oblique (LAO) view, and any other special angle of X-ray beam has not been used. Thanks to the recent production of large X-ray generator, the X-ray tube

output has increased markedly; thereby, the resolution of the X-ray cine film has improved and it has become possible to obtain clear images through special projection methods, thus contributing to the establishment of an accurate diagnosis. We have recently devised new methods of projection which enable us to obtain a clearer view of the lesion. The present paper describes some projections which are helpful to improve the accuracy of the diagnosis of mitral valvular diseases.

PROJECTION METHOD AND ANATOMICAL CHARACTERISTICS

Three methods of projection which are helpful in the diagnosis of the mitral valvular disease are presented. The following 3 actual projection methods and the anatomical characteristics of the images in each projection are explained:

- 1) long axial projection (hepato-clavicular, long axial oblique, etc.)
- 2) mitral orifice projection
- 3) combined long axial and mitral orifice projections

Key Words:

Cineangiocardiology
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Fig. 1. Superior PA view.
X-X', x-x' = hepato-clavicular projection, Y-Y', y-y' = long axial oblique projection

Fig. 2. Anteroposterior view (left) and lateral view (right) at hepato-clavicular projection.
★ = anterior mitral leaflet, * = posterior mitral leaflet

1) Long Axial Projection

This method was designed by Elliott et al^{1,2} of the Alabama group in 1977. The heart is projected in the shape of an inverted cone with the atrio-ventricular valve at the base and cardiac apex at the top. A given point on the long axis of the heart is projected at right angles to the X-ray beam.

Hepato-clavicular Projection (HCP)

As shown in Fig. 1, the X-ray beam is projected onto the long axis of the heart at X-X', and the lateral view also becomes the x-x' projection when observed by using vertical and horizontal x-ray beams. The appearances of the

Fig. 3. Anteroposterior view (left) and lateral view (right) at long axial oblique projection.

★ = anterior mitral leaflet, * = posterior mitral leaflet, → = anterolateral commissure, — = posteromedial commissure

mitral apparatus on the AP and lateral views are shown in Fig. 2.

The AP view is characterized by 4 chambers, (atria and ventricles) on the same surface, and is also referred to as the "4-chamber view". In AP view, the mitral annulus can be observed tangentially, but since the mitral annulus is superimposed with the left ventricular (LV) outflow and dorsal vertebrae, it is not considered as a very good method.

In the lateral view, which is different from the conventional RAO projection method, the mitral annulus does not overlap with the LV outflow. Furthermore, the anterior and posterior mitral leaflets can be viewed tangentially, so it is valuable for evaluating the presence of prolapse or ballooning of the valvular leaflet. The lateral view of the left ventriculography by this HCP is roughly identical to the long axis view of two dimensional echocardiogram.

Long Axial Oblique Projection (LAOP)

This method is a projection shown as the Y-Y' and y-y' directions in Fig. 1. Vertical and horizontal X-ray projections are made at a slightly shallower LAO and a more slanting body axis than in HCP. In the AP view, the two commissures of the mitral valve are separated to both sides of the LV outflow in this projection as shown in Fig. 3. In the lateral view, since the separation of the mitral annulus and LV outflow is better than that in HCP, the mitral apparatus is visualized well. Particularly, the AP view is appropriate for determining the changes in the

Fig. 4. Mitral orifice projection (RAO 30°, slanting 20°).

★ = anterior mitral leaflet, • = posterior mitral leaflet, → = anterolateral commissure, — = posteromedial commissure

Fig. 5. Combination of the mitral orifice projection (vertical view) and long axial oblique lateral projection (horizontal view).

commissure or the location of the mitral regurgitation.

2) Orifice Projection

The valvular orifice can be viewed en face. The size of the valvular leaflet, status of opening, valve area, and degree of fusion of the commissure can be evaluated by the negative jet stream from the left atrium into the ventricle. When there is thickening of the valvular leaflet, the coaptation zone is visualized as a radiolucent zone at the systolic phase. However, when regurgitation is severe, the lumen on either side of the valve becomes filled with the contrast media, therefore, we consider this method is not so effective.

Mitral orifice projection (MOP): The X-ray beams are projected perpendicularly to the mitral annulus, i.e., roughly parallel to the long axis of

the heart, so as to visualize the mitral valve en face. We could obtain radiograms by setting a patient at the desired positions³ as shown in Fig. 4. When radiograms of the left ventricle are taken simultaneously in 2 directions, the RAO view is obtained by vertical X-ray beams from a horizontal direction. By left ventriculography, not only the degrees of changes in the valve area and commissure zone which are identified as mentioned above, but also the changes of the subvalvular tissue in the commissure zone and the contraction of the mitral annulus can be observed and measured. The moving site of the ventricular septum and papillary muscles through the cardiac cycle can also be visualized. This view is well corresponded to the short axis view of two dimensional echocardiogram.

3) Combined Long Axial and Mitral Orifice Projections

By combining the body position shown in Fig. 5 and the direction of the X-ray beam, the MOP is obtained by vertical X-ray beam, and the lateral view of LAOP by horizontal X-ray beam. This projecting method provides the most valuable information for analyzing the diseased condition of the mitral apparatus.

APPLICATION FOR MITRAL VALVULAR DISEASE

The advantages of these methods for detecting mitral valvular lesions are described as follows in comparison with the conventional AP, lateral, RAO and LAO views.

By angiocardiology we must evaluate the various sites of the mitral apparatus, such as the anterior leaflet, posterior leaflet, commissure zone, valvular annulus, chordae tendinae, papillary muscle, left ventricular wall and left atrial wall. Particularly, considering the method of surgical repair to be selected (commissurotomy vs valve replacement), the operative difficulty of making the incision and the preparation of the adhesive valve and subvalvular tissue, and the pliability of the valvular tissue after preparation have to be estimated preoperatively. To date, this evaluation has been made through the RAO of the left ventriculography.

The RAO is a beneficial method for identifying the contractility of the left ventricular wall and the changes in the subvalvular tissue. The movement of the smooth zone of the valvular leaflet is visualized as a dome formation. The

Fig.6. Lateral view at hepato-clavicular projection. Anterior leaflet (▲) has a plate like appearance, and the swing distance from the annulus can be measured accurately. Posterior leaflet (→) has no movement. The changes in subvalvular tissue are severe.

Fig.7. Mitral orifice projection. The edge of the anterior mitral leaflet (▲) has an incomplete opening. The smooth zone (→) is visualized as a dome formation. The rough zone (---) has a severe thickening. The annular motion is good at the free wall of left ventricle (.....).

TABLE I CASE NUMBER OF RHEUMATIC MITRAL VALVE DISEASE

Diagnosis	Method of angio.			Total
	Conventional	Hepato-clavicular position	Mitral orifice view	
Stenosis	42	26	53	121
Regurgitation	60	47	5	112
Stenoin sufficiency	60	30	21	111
Total				344

conventional: only conventional RAO, LAO and lateral projections were used. In the cases examined at the hepatoclavicular position and mitral orifice view, conventional left ventriculography was also performed at the RAO, LAO and lateral views.

Fig. 8. Illustration of the commissural area.
AML = anterior mitral leaflet, PML = posterior mitral leaflet, CA = commissural area

disadvantages of the RAO are as follows: firstly, in the RAO projection at the usual 30 degree angle, the mitral annulus is not visualized so tangentially as it has been generally considered; secondly, at systole, the upper half of the mitral annulus overlaps with the LV outflow; and thirdly, the anterior and posterior leaflets are not

separated clearly. Thus, detailed observations of each rough zone and commissural area of both leaflets are unlikely to be obtained separately. The grade of dome formation and the accurate swing distance from the annulus surface cannot be measured by this projection angle and the results are not always reproducible.

Such problems can be solved by left ventriculography at HCP or LAOP. The lateral view is especially useful for the accurate observation of the rough and smooth zones of the valvular leaflet (Fig. 6). The AP view obtained simultaneously is helpful in evaluating the morphological changes of the anterior and posterior commissures separately. The MOP has the advantage of determining the pliability of the valvular annulus, by which the detection of the rheumatic lesions extended to the valvular annulus may be made accurately (Fig. 7).

When the mitral regurgitation is not too dominant, MOP is very helpful. When there are severe changes in the valve and subvalvular tissue, these findings are easier to recognize. The advantageous characteristics of this projection method

Measurement of Mitral Apparatus

	normal	MR	MSR	MS
AML area (cm ²)	8.4	9.6	7.9	7.0
PML area (cm ²)	4.6	7.0	4.2	4.7
annul. circum. (mm)	122	150	110	103
annul. diamet. (mm)	39	48	34	33

Fig. 9.

are better demonstrated on reviewing the valvular annulus as this cannot be obtained by other projections.

Thus, MOP and the lateral view of LAOP are especially useful for the diagnosis of the mitral apparatus. We are now performing left ventriculographies at various projections to obtain the correct diagnosis of the mitral valvular lesions.

MEASUREMENT OF MITRAL APPARATUS IN VARIOUS MITRAL VALVE DISEASES

Three hundred and forty-four patients with mitral valvular disease were subjected to left ventricular angiography during the period of October, 1977 to July, 1980 at the National Cardiovascular Center. The details are listed in Table I.

Measurements of mitral valve component were done on 90 patients: 30 with mitral stenosis (MS), 30 with mitral regurgitation (MR) and 30 with steno-insufficiency (MSR). They were 47 males and 43 females. Their ages ranged from 32 to 67 and their heights from 143 to 176 cm with an average of 162 cm. Twenty normal cases were studied as the controls. Annulus circumference was traced in the end-diastolic phase and the anterior mitral leaflet (AML) area was calculated in a certain frame of the systolic phase. The commissural area was defined as illustrated in Fig. 8. This area was not incorporated into the anterior and posterior leaflet areas. The posterior leaflet area was obtained by subtracting the AML and commissural areas from the traced valve annulus area.

The results of the measurement are demonstrated in Fig. 9. The annulus circumference was 122 ± 5 mm in normal control group, 150 ± 7 mm in MR group, 110 ± 2 mm in MSR group and 103 ± 2 mm in MS group. Annulus diameter measured at its longest axis showed 39 ± 2 mm in normal control group, 48 ± 5 mm in MR, 34 ± 1

mm in MSR and 33 ± 3 mm in MS. AML and PML areas were 8.4 ± 0.5 cm², 4.6 ± 0.2 cm² in normal control group, 9.6 ± 0.7 cm², 7.0 ± 0.3 cm² in MR, 7.9 ± 0.4 cm², 4.2 ± 0.2 cm² in MSR and 7.0 ± 0.6 cm², 4.7 ± 0.5 cm² in MS, respectively.

It is concluded from the present study that the annulus circumference was increased by 25% in MR group in comparison to normal controls. The increase in area of the anterior leaflet was not dominant, whereas that of the posterior leaflet was found to be 50%. In the MSR and MS groups, in accordance with the severity of the rheumatic changes, the area of the anterior leaflet tended to decrease and that of the posterior leaflet tended to increase relatively speaking. In other words, coaptation of the 2 leaflets occurred at the central portion of the mitral orifice. Particularly, the finding that the diameter of annular ring was markedly increased as well as the increase of posterior leaflet area in MR group, would be explained through the fact that addition of coaptation area to the posterior leaflet area was produced by the enlargement of annular ring at the site of left ventricular free wall, which subsequently produced the increase of posterior leaflet area.

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