Evaluation of Routine Serial Fluoroscopic Examinations of the Heart in the Postero-anterior and Oblique Views at Specific Degrees of Rotation

With Special Reference to the Angle of Clearance of the Left Ventricle

By May G. Wilson, M.D., Nathan Epstein, M.D., Helen N. Helper, M.D., and Katharine Hain, M.D.

An evaluation of 2973 serial fluoroscopic examinations at specific degrees of rotation for 500 subjects 2 to 21 years of age, made by 35 different observers with an average of five examiners per patient, is presented. In the postero-anterior view, 1 per cent showed convexity of the pulmonary segment. In the right anterior oblique position 1 per cent showed retrodisplacement of the esophagus. The angle of clearance of the left ventricle in the left anterior oblique position was less than 55 degrees in 93 per cent of the fluoroscopic examinations. In addition, 1393 routine serial fluoroscopic examinations of 100 patients with inactive rheumatic heart disease, 4 to 48 years of age, were analyzed. There was a total of 49 observers, an average of 8 per patient. The angle of clearance of the left ventricle ranged between 55 and 70 degrees. There was left auricular enlargement in 98 patients. It is concluded that fluoroscopic examination at specific degrees of rotation is a reliable procedure for detecting cardiac chamber abnormality, and should be included as part of the routine examination.

The clinical importance of fluoroscopic examination of the heart in the frontal and oblique views to detect abnormality of the individual chambers is now well established. It is not as well recognized that serial fluoroscopic examinations at specific degrees of rotation afford opportunities for detection of slight degrees of chamber enlargement. This is particularly important for the early diagnosis of active carditis.

In 1934 an investigation was made of roentgenologic criteria for cardiac chamber enlargement. This included cardiothoracic index, cardiac surface area and fluoroscopic examination in oblique views at specific degrees of rotation. In 504 children it was found that

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This study was aided by grants from the Commonwealth Fund and the Helen Hay Whitney Foundation.
tions of 500 children from 2 to 21 years of age who were under continuous medical supervision during the past 15 years as part of a family study were analyzed. The children were fluoroscoped at least annually and during any febrile illness as part of the physical examination. The 2973 fluoroscopic examinations were made by 35 different observers of varied experience. There was an average of five different examiners per child. Fluoroscopic examinations of children presenting evidence on physical examination of organic heart disease, kyphosis, scoliosis, funnel or pigeon breast, were excluded from this analysis. Fluoroscopic examinations of 26 children who developed rheumatic fever while under observation were excluded at the onset of symptoms.

For comparison, 1393 routine serial fluoroscopic examinations of 100 rheumatic patients 4 to 48 years of age, under medical supervision in the Cardiac Clinic during the past 18 years, were also analyzed. These examinations were made by 49 different observers with an average of eight different examiners per patient.

**Observations**

Table 1 shows the distribution of pertinent findings in 2973 routine serial fluoroscopic examinations for 500 patients 2 to 21 years of age. It will be noted that in 1 per cent of the fluoroscopic examinations there was sporadic convexity of the pulmonary segment and in another 1 per cent retrodisplacement of the barium filled esophagus was noted. In 10 per cent, the angle of clearance of the left ventricle was 55 degrees or more.

In table 2, the variations observed in the angle of clearance of the left ventricle in the left anterior oblique position are presented.

**Table 1.—2973 Serial Fluoroscopic Examinations of the Heart in 500 Normal Subjects, 2 to 21 Years of Age—Abnormalities**

<table>
<thead>
<tr>
<th>Posterior-Anterior</th>
<th>Right Anterior Oblique</th>
<th>Left Anterior Oblique</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+ convexity of pulmonary segment</td>
<td>1+ retrodisplacement of barium filled esophagus</td>
<td>Angle of clearance of the left ventricle, 55 degrees or more</td>
</tr>
<tr>
<td>25 (5%)</td>
<td>36 (1%)</td>
<td>20 (4%)</td>
</tr>
</tbody>
</table>

**Table 2.—Angle of Clearance of Left Ventricle in 2973 Serial Fluoroscopic Examinations in 500 Normal Subjects 2 to 21 Years of Age**

<table>
<thead>
<tr>
<th>Degree of Rotation</th>
<th>No. of fluoroscopic examinations</th>
<th>% of fluoroscopic examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 45-50°</td>
<td>299 (10%)</td>
<td>Between 50-55°</td>
</tr>
<tr>
<td>55° or more</td>
<td>544 (18%)</td>
<td>306 (10%)</td>
</tr>
</tbody>
</table>

In 10 per cent of the fluoroscopic examinations, the angle of clearance was less than 50 degrees; in about two-thirds it was 50 degrees, and in about one-fifth it was more than 50 degrees but less than 55 degrees. It will be seen that in 90 per cent of the fluoroscopic examinations (80 per cent of the children) the angle of clearance was less than 55 degrees, confirming the observations of the previous investigations.

The angle of clearance was less than 50 degrees in vertically placed hearts and slightly more than 50 degrees in transverse hearts, particularly in obese children with high diaphragms. Following periods of rapid growth the angle of clearance was observed to decrease slightly. Sporadic variations in the angle of
clearance were observed three times as often in the age group of 6 to 13 years than before or after this age period.

Of the 98 patients (20 per cent) who showed angles of clearance of 55 degrees or more occasionally, this occurred in 35 patients once, in 18 twice and in 45 patients three or more times. In patients with persistent angles of clearance between 50 and 55 degrees, slight lordosis was frequently observed. In 53 patients observed to have angles of clearance of 55 degrees one or more times, it was recorded that there was poor posture or poor cooperation.

Progressive increases in the angle of clearance of the left ventricle and retrodisplacement of the esophagus were noted in 26 patients who developed rheumatic fever while under observation. It is important to note that patients experiencing febrile illnesses did not have any detectable change in the cardiac silhouette in the postero-anterior or oblique views.

In 100 patients with inactive rheumatic heart disease, aged 4 to 48 years, observed for 2 to 18 years in the Cardiac Clinic, 12 had aortic and mitral insufficiency with mitral stenosis, 28 had mitral insufficiency and stenosis, 50 had mitral insufficiency and 10 patients had uncharacteristic systolic murmurs with cardiac chamber enlargement. In 1393 serial fluoroscopic examinations of these patients the angle of clearance in this group ranged from 55 to 70 degrees. There was left auricular enlargement in 98 patients. In 90 per cent of the fluoroscopic examinations the angle of clearance of the left ventricle did not vary in the absence of a recurrent attack of rheumatic fever. In 10 per cent of the fluoroscopic examinations there were variations of 5 degrees or more. This occurred most frequently in patients with angles of clearance of 60 or 65 degrees. It is significant that although cardiac chamber enlargement persisted unchanged, characteristic murmurs of valvular deformity regressed in 28 patients during the period of observation and became uncharacteristic in 46.

**Comment**

In recent years fluoroscopic examination has become part of the routine examination in office and clinic practice. In differentiating the normal from the abnormal heart, the normal variations in cardiac silhouette due to body build must be considered. The reliability of the angle of clearance of the left ventricle as an index of left ventricular enlargement depends on the care exercised to avoid errors. It is essential that the child stand erect, arms at the side, and be cautioned not to move. The clearance of the left ventricle from the bodies of the vertebra should be observed during normal respiration. The low incidence of variations in the angle of clearance of the left ventricle in the routine serial fluoroscopic examinations at specific degrees of rotation by observers of varied experience is worthy of note. The possibility that the examiners were influenced by previous fluoroscopic findings was considered. It was found, however, that variations occurred as frequently when performed by the same as by different examiners.

The observations presented confirm the reliability of the fluoroscopic criteria established in the previous investigation. Of particular interest is the finding that the normal angle of clearance was less than 55 degrees in 90 per cent of the serial fluoroscopic examinations.

The normal range in the angle of clearance, that is, between 45 and 55 degrees, emphasizes the importance of including fluoroscopy as part of the initial examination. This is especially important in children of rheumatic families in whom slight changes in the cardiac silhouette, within the normal range, would make possible an early diagnosis of active carditis. However, an angle of clearance of 55 degrees or more would appear to be presumptive evidence of left ventricular enlargement.

The fluoroscopic evidence of cardiac chamber enlargement is of special importance in patients with inactive rheumatic heart disease in whom auscultatory signs of valvular deformity regressed or became uncharacteristic. It is obvious that residual cardiac damage in rheumatic fever cannot be excluded on physical examination alone.

**Summary and Conclusions**

An evaluation of 2973 routine serial fluoroscopic examinations in the posterior-anterior
and oblique views at specific degrees of rotation is presented for 500 normal subjects. These patients, 2 to 21 years of age, were under medical supervision during a 15-year period of observation as part of a family study. Examinations were made by 35 different observers of varying experience, with an average of five observers per patient.

In the posterior-anterior view, 1 per cent of the fluoroscopic examinations revealed convexity of the pulmonary segment.

There was retrodisplacement of the barium filled esophagus in 1 per cent of the examinations in the right anterior oblique position.

In the left anterior oblique view the angle of clearance of the left ventricle was less than 50 degrees in 10 per cent, 50 degrees in 61 per cent, between 50 and 55 degrees in 18 per cent and 55 degrees or more in 10 per cent of the fluoroscopic examinations. In 90 per cent of the serial fluoroscopic examinations the angle of clearance was between 45 and 55 degrees.

These observations on normal subjects were compared with 1393 routine serial fluoroscopic examinations of 100 patients, 4 to 48 years of age, under medical supervision in the Cardio Clinic with inactive rheumatic heart disease for the past 18 years. Examinations were made by 49 different observers with an average of eight different observers per patient.

The angle of clearance of the left ventricle ranged from 55 to 70 degrees. There was left auricular enlargement in 98 patients. Evidence of cardiac chamber enlargement was obtained in 74 patients although murmurs indicative of valvular deformity had regressed in 28 patients and had become uncharacteristic in 46.

It is concluded that fluoroscopic examination in the posterior-anterior and oblique views at specific degrees of rotation is a reliable procedure for detecting cardiac chamber abnormality, and should be included as part of the routine physical examination.

**Serum Español**

Se presenta una evaluación de 2973 exámenes fluoroscópicos seriales a una rotación de grados específicos en 500 sujetos de 2 a 21 años de edad hechos por 35 examinadores diferentes con un promedio de 5 examinadores por paciente. En la posición posterior-anterior, 1 por ciento mostró convexidad del segmento pulmonar. En la posición oblicua anterior derecha 1 por ciento mostró retrodesplazamiento del esófago. El ángulo al cual se franquea el ventrículo izquierdo en la posición oblicua anterior izquierda fue menos de 55 grados en 90 por ciento de los exámenes fluoroscopicos. Adicionalmente, se analizaron 1393 exámenes fluoroscópicos seriales rutinarios de 100 pacientes con enfermedad reumática cardíaca inactiva de 4 a 48 años de edad. Hubo un total de 49 examinadores y un promedio de 8 por paciente. El ángulo de franqueo del ventrículo izquierdo fue de 55 a 70 grados. Se encontró engrandecimiento del aurículo izquierdo en 98 pacientes. Se concluye que el examen fluoroscópico a una rotación de grados específicos es un procedimiento confiable para encubrir anormalidades de las cámaras cardíacas y se debe incluir como parte del examen rutinario.

**References**

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Circulation. 1953;8:879-882
doi: 10.1161/01.CIR.8.6.879

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/8/6/879

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