Detection and Identification of Intracardiac Calcifications

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Introduction

During the past 15 to 20 years the detection in vivo of intracardiac calcifications and their identification has become a fairly common accomplishment in the hands of careful, painstaking roentgenologists. No individual has contributed more toward stimulating his confreres in detecting these lesions than has Merrill Sosman, of Boston. Among technical advances which have greatly aided in the visualization and identification of these lesions might be mentioned the more brilliantly fluorescent screens now commonly employed, the use of high-speed radiographic techniques (faster than 1/10 second), and the application of kymography. One must not fail at this point to emphasize the value of fluoroscopy both for detection and identification of many of these calcifications. The new Westinghouse fluoroscopic image amplifier or the Moon scanning tube, when perfected and available for general use by fluoroscopists, may render visible the more minute calcifications which are today revealed only with difficulty or not at all. I am, nevertheless, thoroughly convinced that to reduce the errors of omission and to aid in matters of differential diagnosis and exact localization, with present-day equipment, we do need high-speed, multiple, aimed, "spot" roentgenograms. Not only will calcification associated with coronary arteriosclerosis be much more frequently revealed, but occasionally other intracardiac calcifications, particularly the less marked degrees of valvular and annulus calcifications which cannot be visualized on roentgenoscopy, will be demonstrated. We have been using multiple, "spot," aimed, high-speed roentgenograms for study of the heart substance routinely for approximately five years, during which time the incidence of cases of calcification due to coronary arteriosclerosis exceeds that of valvular, myocardial, and pericardial calcifications combined. Our patients are for the most part of middle age or older. Many of those examined are highly intelligent private patients who want exact guidance as to their future physical and mental activities. Others are in the group who may

be suffering both from occupational and non-occupational disease, and a most careful evaluation of all data obtainable is essential to the proper disposal of their claims before the Wisconsin State Industrial Commission. Our series includes approximately 100 cases of intracardiac calcification. We have as yet seen no case of calcified tumor nor any case of the endocardial calcification (excluding coronary atherosclerosis) which is said to occur occasionally on the endocardium opposite a septal defect, nor have we been certain of identifying calcification in the membranous septum as may occasionally be demonstrated in patients with heart block.

**Technique**

All patients who are 40 years or older are carefully examined fluoroscopically with orthodiagraphy, and in addition to teleroentgenograms and esophagrams we take multiple, high-speed, aimed, “spot” roentgenograms on the same tunnel device permitting four exposures on a 10 x 12 film which many radiologists use for multiple radiographic study of the distal stomach and proximal duodenum or other portions of the gastrointestinal tract on certain occasions. The important point of difference technically is that we change slightly the position of the patient for each “spot” film exposure, thereby aiding greatly in differentiating intra- from extracardiac calcifications. By means of this last-mentioned technical procedure applied routinely with small cone and short target-film distance (usually consisting of a single 10 x 12 roentgenogram with four exposures contained thereon) we have found an appre-
ciably larger number of intracardiac calcifications, particularly coronary but also occasionally valvular calcifications, which would otherwise have been missed because of failure to visualize them with certainty fluoroscopically. I doubt not that radiologists differ in keenness of fluoroscopic vision, just as the keenness of perception may vary in a given individual from hour to hour or day to day, according to his physical fitness. We have for some time felt justified in placing chief reliance upon the multiple, high-speed, aimed, "spot" roentgenograms, aided occasionally by evidence obtained on kymography for the detection and identification of smaller intracardiac calcifications, just as many radiologists rely upon a series of routinely taken gastrointestinal or chest films to bring out the maximum diagnostic information regarding the more minute pathologies in these tracts which might otherwise be overlooked with roentgenoscopy alone or roentgenoscopy plus a minimum number of roentgenograms.

**Significance**

Concerning the significance of cardiac calcification, this may vary from the calcifications of the annulus fibrosus of the mitral or aortic valves which have no particular clinical importance, to ones in the valve leaflets or in the myocardium, which may contribute importantly to the diagnosis of chronic valvular heart disease¹ or previous myocardial infarction or pericarditis.² Coro-

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**Figures 2 and 3:** Calcified myocardial (anterior apical) infarct. Female, age 39, cardiac complaints, only four months' duration. Mild hypertension and mild heart failure clearing shortly prior to admission to hospital December 1, 1949. ECG confirmed presence of previous myocardial damage. No angina at time of attack or subsequent thereto. Bucky technique P.A. film reveals form of calcification better than non-Bucky films. Oblique shows characteristic distribution over anterior apical portion of left ventricle.
Intracardiac calcifications

Coronary artery calcification per se may or may not be significant in relation to the patient's symptoms and medical history, and as stated by Sosman, "is to be reported as such." We may very properly add, however, that nearly all coronary arteriosclerosis is atherosclerosis and as such must be considered at least potentially dangerous, particularly when occurring in the earlier decades of life.

**Incidence**

The incidence of the various types of calcification would be influenced considerably by the age of the group studied. In a clinic or practice where upper age groups predominate, calcifications of the annulus fibrosus, the aortic valve, and the coronary arteries will occur with greater frequency than mitral valvular, myocardial, or pericardial calcifications. The youngest patient in whom the writer has seen calcification of the mitral valve was a male patient of 23 years whose past history for rheumatic infection was rather vague and inconclusive. The youngest patient with calcification seen in the aortic valve was a male of 39 years. A female, aged 39, was seen recently whose calcification was unquestionably myocardial. The youngest patient with well-defined coronary arteriosclerosis was a male, age 50.

**Pericardial Calcification**

Extensive pericardial calcifications in the personal experience of the writer have occurred more often than not as incidental findings and were apparently unassociated with any serious con-

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**FIGURE 5:** Mitral leaflet calcification. Male, age 24, recent hemoptysis, clinical suspicion auricular septal defect. P.A. and right oblique esophagograms show characteristic left auricular enlargement. Note low position of calcified mitral leaflets in relation to arc of esophageal compression.
strictive pericarditis phenomena. Several of these have been seen in individuals in the sixth or seventh decade who have enjoyed good health for many years and who have shown no signs of cardiac embarrassment or failure. One gave no history of previous pericarditis. The usual site of location is over the surfaces of the ventricles and as would be expected in the absence of any evidence of constrictive pericarditis clinically, these cases have shown fairly active excursions of the ventricular borders despite the encasement of the heart by large calcified placques (Figure 1). Sosman states that pericardial calcifications may be found as a ring along the auriculoventricular sulcus, or occasionally over the auricles.

Myocardial Calcification

Myocardial calcifications are of several types and etiologies, undoubtedly the most common being on the basis of an old massive myocardial infarction. The commonest location is the anterior apical portion of the left ventricle (Figures 2 and 3). We have seen two such cases, one recently, the other about 15 years ago (each with what might be described as a basket-weave type of calcification resembling somewhat a thick shell of a half egg when x-rayed in profile). The first was described by the internist reporting the case as resembling a “quarter moon.” The one seen recently was found in a woman age 39, who had no history of previous coronary infarction, her cardiac history being based on symptoms going back a relatively short period of four months’
time (Figures 2 and 3). Sepsis and calcium metastasis are also stated to be causes of calcification of the myocardium, but apparently the distribution in these pathologies is not of a type which would make them detectible roentgenographically.¹,³

Valvular and Annulus Calcification

Probably in the experience of the average radiologist devoting only the usual amount of radiographic effort to the discovery of intracardiac calcification, this group would comprise his largest collection. Annulus calcifications of the mitral and less often the aortic ring are by no means rare in patients in the upper age groups and when being seen for the first time by the fluoroscopist afford considerable interest because of their large dancing excursions. The wide movement in opposite direction from the movement of the heart apex can be readily defined on careful analysis of the kymograms, as was pointed out by Rigler.⁹ Also its wide excursion will frequently be radiographically revealed on our "four-on-one" multiple "spot" roentgenogram (Figure 4). Occasionally when the clinician is in doubt as to whether the chief cardiac lesion is a congenital or an acquired one (Figures 5, 6, 7 and 8) or when the clinical picture may not be clearly indicative of a valvular lesion, the x-ray detection of calcification of the aortic or mitral valve leaflets will add greatly toward the correct clinical evaluation.⁴,⁷,¹¹,¹² Differentiation between annular and leaflet calcification is easier in the mitral area than in the aortic

![FIGURE 8: Mitral valve calcification. Right anterior oblique and left lateral teleroentgenograms adequately exposed (penetrated) to show intracardiac calcification of mitral leaflets. Note again the low posterior position of the valve during systolic phase. Characteristic esophagram findings again present. (Rarely, the esophagram may be normal). At post mortem some minimal calcification also present in aortic leaflets, not detected in vivo.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21216/ on 06/25/2017)
because the mitral valve ring calcification is actually somewhat less than a complete ring, being usually reversed-C or U-shaped. When a complete ring is formed or when there is a nodular thickening of calcareous deposits at the posterior branch of the calcified ring, as described recently by Windholz of Stanford, one has radiologic evidence of extension of the calcification into the interventricular septum, this pathology being usually associated with heart block. The average age of patients having ring calcification is, of course, greater than those having leaflet calcification. However, the average age of patients with aortic calcification when detected in vivo is usually rather high, in contrast with which the mitral leaflet calcifications occur at a somewhat younger age. As seen in postero-anterior study, aortic calcifications ordinarily are at a somewhat higher and more medial position than mitral calcifications. They are also in a somewhat more anterior position (Figures 9, 10, 11 and 12). However, these valves, it is to be emphasized, are anatomically not very widely separated, and differ-

FIGURE 9: Aortic valve calcification, female, age 64, known “leakage” for twenty years, left ventricle moderately enlarged. “U” form configuration revealed in “spot” roentgenogram lower left corner “four-on-one” roentgenogram. Formless configuration shown in upper right corner oblique projection.
entiation may at times be rather difficult, particularly if one does not have a frank aortic heart configuration or mitral heart configuration as a secondary aid. According to Sosman, if on the postero-anterior roentgenogram one draws an axis line obliquely

![Figure 10: Same case as Figure 9. Position of valve rather high and anterior above auriculoventricular groove, shown on kymogram with patient in shallow left anterior oblique position.](image)

![Figure 11: Left oblique kymograms, aortic valve and mitral valve calcifications, showing relatively similar position within cardiac outline when patient is examined in left oblique position. P.A. or right anterior oblique study more helpful in differentiation of valve involved.](image)
downward and to the right beginning at the auriculo-ventricular junction of the left heart border, both the mitral and aortic valves will lie in close relationship to this axis, the aortic being usually to the right and above it and the mitral to the left and below it. One should read, if interested, this article in order to fully realize the wide area within which either the mitral or the aortic valve may lie (these two areas showing considerable "overlap"), in relation to the anterior chest wall when the heart is enlarged and deformed because of valvular disease. In calcified annulus cases the shadows are likely to be larger and denser and on the films more homogeneous than the mottled calcifications of the mitral or aortic leaflets. There is also said to be a slight difference in the character of the dancing excursion which the leaflets show as compared with the ring. It cannot be emphasized too strongly that routinely exposed teleodentenograms will seldom reveal these abnormalities; careful search during fluoroscopy with complete dark room adaptation of the eyes, usually with the patient rotated into shallow right and left oblique positions, is necessary to "uncover" them; then the areas can be marked with a skin pencil applied to the posterior chest wall to indicate where the cone should be centered. Just as in "spotting" the patient for the "four-on-one" coronary study, so with the valvular calcifications the same radiographic technique may be used to great advantage in making detailed study of the character and movements of the densities. The kymogram is another means of studying and showing graphically for teaching purposes the nature of the ring and leaflet movements.  

**Coronary Arteriosclerosis**

That even marked degrees of coronary sclerosis may at times be present without clinical angina is well established by careful correlation of clinical history and post mortem studies of coronary pathology. This has prompted Sosman to say that "it indicates a specific type of damage in the specific case which can be reported only as such." Nevertheless, in a large series of 762 cases studied by Levy, Bruenn, and Kurtz, arteriosclerotic heart disease was the most frequent primary cause of death and cardiac insufficiency was the commonest terminal event. The importance of demonstrating and thus knowing the presence of coronary arteriosclerosis would be in inverse proportion to the age at which it was found. That is, it would be more significant if revealed in a patient age 50 than in one age 75 (Figure 14).

It is furthermore of interest to note that while coronary arteriosclerosis is very prevalent, it need not be accepted as inevitable that we all have it if we live to an advanced age. Ivy in a recent
discussion of drug therapy in degenerative diseases⁶ quoting post mortem findings observed by Groddeck noted that 34 per cent of 283 persons of over 80 years of age had only slight sclerosis of the coronaries, while just 3 per cent of the group had only slight changes in the aorta. The youngest patient in our series of coronary arteriosclerosis was a male, age 50, who had had clinical angina pectoris for about one year (Figure 15). Considering distribution

**FIGURE 14:** Left coronary arteriosclerosis. Male, age 59, end-on visualization of left coronary vessel with patient in left anterior oblique position, calcification visible fluoroscopically, also characteristically revealed in left oblique kymogram, which latter may reveal presence of lesser degrees of coronary sclerosis not visible on fluoroscopic study.

**FIGURE 15:** Left coronary arteriosclerosis. Male, age 50 (youngest case in our series of clearly definable coronary calcification). Rather characteristic angina for period of approximately one year. (From the amount of sclerosis present at time of x-ray study, one might reasonably conclude that this individual would have revealed x-ray evidence of the pathology at least a year or two earlier, had search been made at earlier date).
of sclerosis in a series of 34 cases studied by Saphir, Priest, Hamburger and Katz, "Sclerotic plaques involving both the right and left arteries were found in 23 cases, in eight cases the left only was involved, and in two cases the right only."

Concerning the relationship of sclerosis in the aorta and sclerosis in the coronary arteries, we have been able to demonstrate frank sclerotic plaque formation in the coronary vessels in a number of instances where no plaques could be demonstrated in the aortic arch. It behooves us, therefore, to make just as intensive search in the older age groups for coronary arteriosclerosis regardless of whether or not we have fluoroscopic or radiographic evidence of plaque formations in the aortic arch.

Both on fluoroscopic examination and on multiple, aimed, "spot," high-speed roentgenograms we devote greater time and effort to the discovery of left coronary artery changes than right, for the two-fold reason of the greater incidence of more marked changes and because of their earlier occurrence in the left vessel and its branches. By varying the position of the patient slightly toward the right and left oblique positions for each of the four exposures on a 10 x 12 film, we can greatly facilitate the differentiation of coronary or other intracardiac calcifications from extracardiac calcifications, particularly calcified cartilages, bronchi, glands, or costovertebral articulations (Figure 13).

SUMMARY

The detection of intracardiac calcifications constitutes a fascinating study for the radiologist who is seeing cardiac patients in the older age groups and who has the time and interest to make adequate fluoroscopic and radiographic examination of each patient coming to him.

While the importance of roentgenoscopy cannot be overemphasized, multiple, aimed, "spot," high-speed roentgenograms will increase the incidence of detection and identification of these calcifications. A simple technical procedure for accomplishing this end result is described and recommended.

RESUMEN

El descubrimiento de las calcificaciones intracardíacas es un estudio muy atractivo para el radiólogo que ve enfermos cardíacos de edad avanzada y que tiene tiempo e interés para hacer exámenes adecuados fluoroscópicos y radiográficos en cada enfermo que a él viene.

Si bien la importancia de la radioscopia no puede jamás exagerarse, los roentgenogramas, múltiples, enfocados y localizados (spot) a alta velocidad, aumentan la frecuencia de los hallazgos
e identificación de esas calcificaciones. Un procedimiento técnico sencillo para obtener esto, se describe.

RESUME

La découverte des calcifications intracardiaques est extrêmement intéressante pour le radiologiste. Elle demande que l'examen soit fait avec précision, et sans hâte chez tous les malades âgés, qui viennent se faire examiner radiologiquement le coeur.

Bien qu'on ne dira jamais assez l'importance de la radiooscope, les radiographies, faites nombreuses, bien dirigées, à très grande rapidité, augmenteront la fréquence de la découverte et de l'identification de ces calcifications. L'auteur décrit et recommande un procédé technique très simple qui permet d'obtenir ces résultats.

REFERENCES