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ANGIOCARDIOGRAPHY OF PERSISTENT COMMON ATRIOVENTRICULAR CANAL*

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The appearance of the left ventricle in the frontal left ventricular angiocardio-gram in cases of persistent common atrioventricular canal is characteristic.¹⁻³ Baron and colleagues² have lucidly described the anatomic basis for the angiographic pattern. In their words, "this method appears to be the most accurate single diagnostic technic available for the identification of these lesions." The left ventricular angiographic appearance, however, has been considered to be basically the same in all varieties of common atrioventricular canal and therefore not particularly helpful in differentiating between the partial form (without interventricular communication) and the complete form (with interventricular communication).

In a previous paper,⁴ hearts exhibiting the complete form of atrioventricular canal were regrouped into three categories on the basis of the anatomy of the anterior common atrioventricular leaflet and the size and site of interventricular communication (Fig. 1). The recognition and preoperative diagnosis of the exact type of complete atrioventricular canal are important, since the severity of this malformation, as well as the surgical mortality, is related to the anatomy.⁵ For these reasons, the angiocardio-graphic findings in all cases of persistent common atrioventricular canal seen at the Mayo Clinic were reviewed in an attempt to find possible angiographic clues to differential diagnosis.

MATERIAL AND METHOD

Twenty-nine patients who had persistent common atrioventricular canal and whose intracardiac anatomy had been described surgically or pathologically were studied. A left ventricular angiocardio-gram was available on 27 patients, of whom 14 had the partial form, 4 a common atrium, and 9 the complete form of persistent common atrioventricular canal. A right ventricular angiocardio-gram was available on 17 pa-

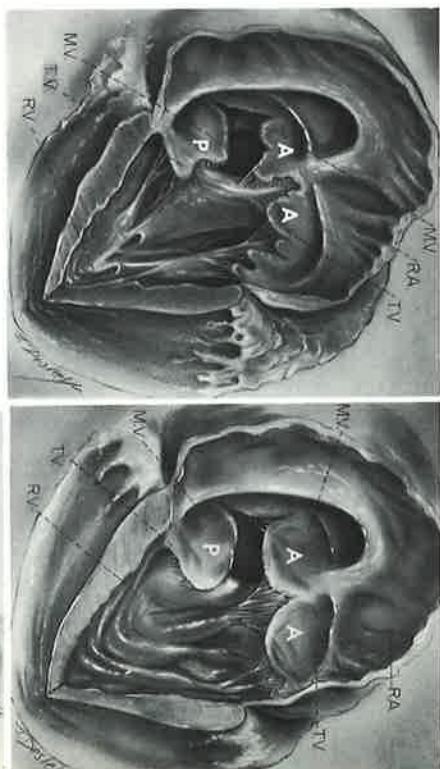


Fig. 1. Types of complete form of persistent common atrioventricular canal. *Upper Left*, Anterior common leaflet (A) is divided into two portions: mitral (MV) and tricuspid (TV), both medially attached to ventricular septum. *Upper Right*, Anterior common leaflet (A) is divided into two portions: mitral (MV) and tricuspid (TV), both medially attached to an anomalous papillary muscle into right ventricle adjacent to septum. *Lower*, Anterior common leaflet (A) is undivided and unattached to ventricular septum (*inset*). RA = right atrium; RV = right ventricle; P = posterior common leaflet.



tients, of whom 6 had the partial form, 3 a common atrium, and 8 the complete form of persistent common atrioventricular canal. Of the nine patients who had the complete form and on whom a left ventricular angiocardio-gram was available, seven had the type illustrated in Figure 1 *upper left*, one the type illustrated in Figure 1 *upper right*, and one the type illustrated in Figure 1 *lower*.

RESULTS

Left Ventriculogram.—Various degrees of deformity of the left ventricular outflow tract with the characteristic elongation and narrowing, more pronounced in diastole (Fig. 2 A) but visible also in systole (Fig. 2 B), were present in the frontal left ventriculogram of all but one patient (Fig. 3 A). This

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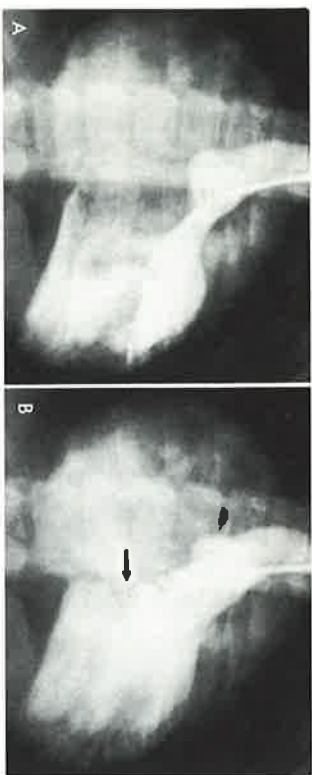


Fig. 2. Frontal left ventricular angiogram in a case of complete atrioventricular canal of the type illustrated in Figure 1 *upper left*.
 A, Diastole. Note elongation and narrowing of left ventricular outflow tract. Nonopacified blood is entering left ventricle, and superior segment of divided anterior leaflet of mitral valve is pushed upward, producing the characteristic deformity. B, Early systole. Note that elongation and narrowing of left ventricular outflow tract are less evident. Right border of ventricle is scalloped and has a deep notch (arrow), from which region a jet originates.

patient had complete atrioventricular canal with anterior common leaflet divided and medially attached to the septum (Fig. 1 *upper left*). At operation, the interatrial communication was fairly small (about 1.5 cm in diameter); the left ventricular outflow tract was partially obscured by contrast medium ejected into the right ventricle (Fig. 3 *B*) through the interventricular communication.

In cases of persistent common atrioventricular canal, the right border of the left ventricular angiogram in the

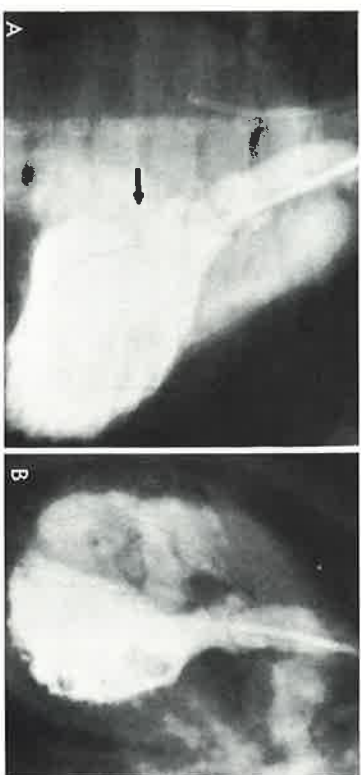


Fig. 3. Complete atrioventricular canal of the type illustrated in Figure 1 *upper left*. A, Frontal left ventriculogram in diastole. The "goose-neck" deformity of the left ventricular outflow tract is not evident. Arrow points to indentation corresponding to site where mitral components of common valve coapt. Right border of left ventricle is partially obscured by contrast medium being ejected through ventricular septal defect into right ventricle. B, Lateral simultaneous left ventriculogram clearly demonstrates interventricular communication.

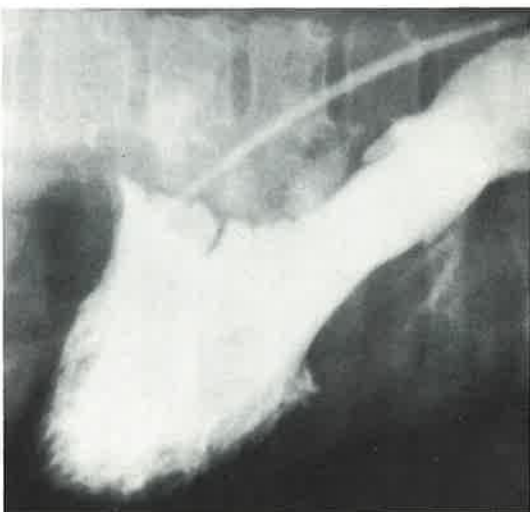


Fig. 4. Frontal left ventriculogram in systole in a case of partial atrioventricular canal. Note elongation and narrowing of left ventricular outflow tract. Right outline of ventricular silhouette is scalloped and has a deep non-opaque indentation at the site where the two portions of the divided anterior mitral leaflet coapt.

frontal projection is, for the most part, formed by the two portions of the cleft anterior leaflet of the mitral valve. It appears serrated and scalloped, and a single, deep, nonopaque indentation, seen in systole, indicates the site where the two portions of the divided anterior leaflet of the mitral valve coapt. This appearance has been recognized, more or less clearly, in all cases of partial atrioventricular canal (Fig. 4), in the cases of common atrium,* and in the seven cases of complete atrioventricular canal in which the anterior common leaflet was divided and attached medially to the septum (Fig. 2 and 3). A nonopaque, deep indentation has been found in two cases of the partial form in which the anterior mitral leaflet was not completely divided but had only a notch extending about half way across the width of the leaflet. The characteristic appearance of the left ventricle, including the deep nonopaque indentation, persisted after operation and complete suture of the mitral cleft in two cases of the partial form in which a left ventriculogram was taken postoperatively.

In the two cases of complete atrioventricular canal in

*One of these patients had dextrocardia with situs inversus of the viscera.

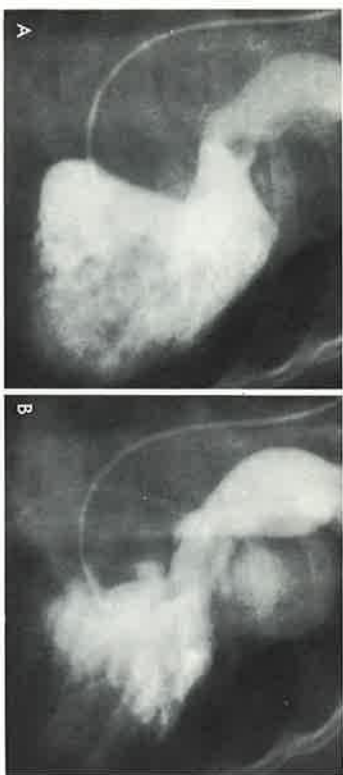


Fig. 5. Frontal left ventriculograms in a case of complete atrioventricular canal of the type illustrated in Figure 1 lower. A, Diastole. Note right-angle appearance of right border of ventricle. Angle's horizontal component is formed by undivided anterior common leaflet in open position, while vertical component is formed by contrast medium trapped under mural mitral leaflet. B, Systole. Note irregular appearance of right border of ventricle, without a finely scalloped contour or a deep indentation.

which the anterior common leaflet was not attached to the septum (Fig. 1 *upper right* and *lower*), the appearance of the left ventricle was atypical both in diastole and in systole. The first of these two cases (Fig. 1 *lower*) was that of a 2-year-old girl. In diastole (Fig. 5 A), the right border of the left ventricle had a peculiar right-angle appearance. The horizontal side of this angle was smooth and was presumably formed by the undivided anterior common leaflet in the open position, while the vertical side of the angle was formed by contrast medium trapped under the mural leaflet of the mitral valve, outlining a portion of the "ring" of the valve. The left ventricular outflow tract, although deformed, did not exhibit the typical "gooseneck" appearance. In systole (Fig. 5 B), the right border of the left ventricle had an irregular outline; the typical serrated appearance and the deep indentation were absent.

The second of the two cases (Fig. 1 *upper right*) was that of a 10-year-old girl who had an associated severe pulmonary stenosis. In this case also, the right border of the left ventricle was, in diastole, somewhat at a right angle (Fig. 6 A), and during systole the serrated appearance and the single deep indentation were absent (Fig. 6 B). This case also shows the pitfall of left ventricular angiocardiography in demonstrating the presence of interventricular communication in this condition.

In most instances, mitral regurgitation was present in cases of the various types of persistent common atrioventricular

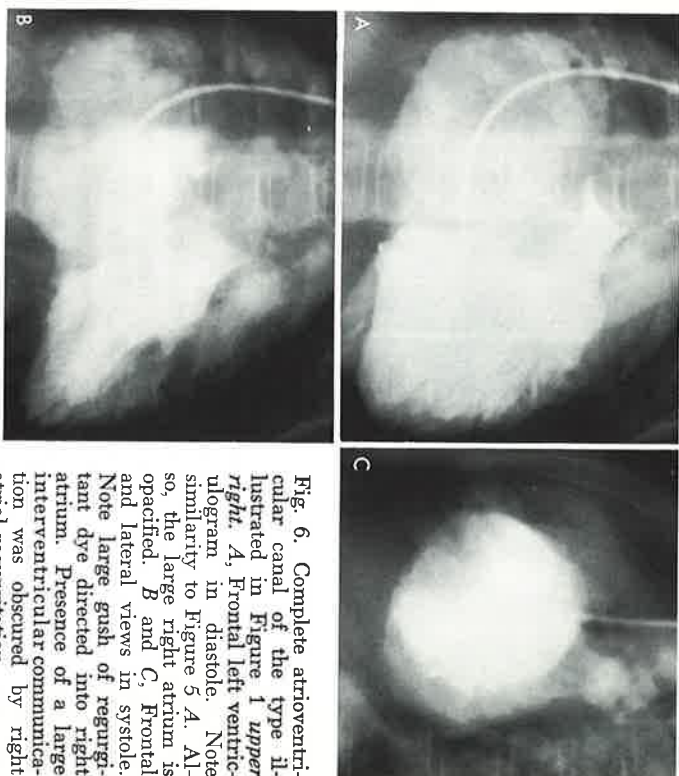


Fig. 6. Complete atrioventricular canal of the type illustrated in Figure 1 *upper right*. A, Frontal left ventriculogram in diastole. Note similarity to Figure 5 A. Also, the large right atrium is opacified. B and C, Frontal and lateral views in systole. Note large gush of regurgitant dye directed into right atrium. Presence of a large interventricular communication was obscured by right atrial regurgitation.

canal. The mitral valve was completely competent in few cases of the partial form, while it was incompetent, although in varying degree, in the four cases of common atrium and the nine cases of complete form. The regurgitant jet may be entirely directed into the left atrium (Fig. 7) or into the right

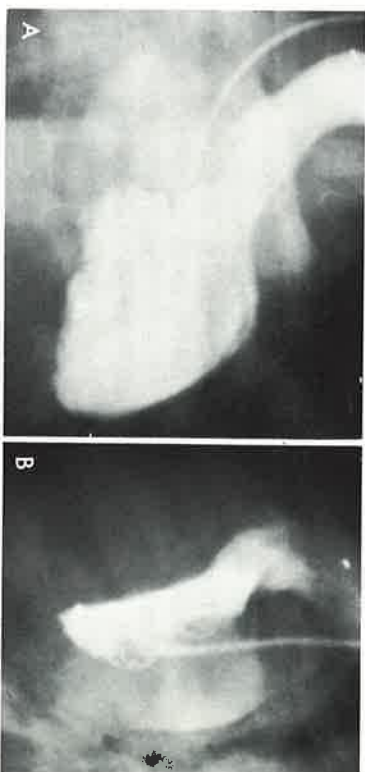


Fig. 7 A and B, Frontal and lateral left ventriculograms in systole in a case of partial atrioventricular canal. Note typical pattern, described in Figure 4. In addition, a jet originates at site of deep indentation and is directed entirely into left atrium.

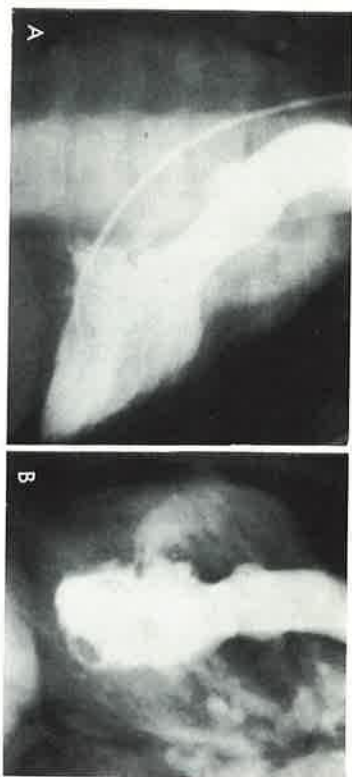


Fig. 8. *A* and *B*, Frontal and lateral left ventriculograms in systole in a case of partial atrioventricular canal. Note typical pattern, as described in Figure 4. A jet originates at site of deep indentation and is directed anteriorly into right atrium, giving the false impression of an interventricular communication, later excluded at operation.

atrium (Fig. 8). In the latter case, the jet regurgitating into the right atrium may be mistakenly thought to represent an interventricular communication (Fig. 8 *B*). A false-positive angiocardiographic diagnosis of interventricular communication was made in 5 of 18 cases of the partial form and common atrium (28%). Conversely, an interventricular communication may be obscured by associated mitral regurgitation directed into the right atrium (Fig. 6 *C*). A false-negative diagnosis of absence of interventricular communication was made from the left ventriculogram in two of nine cases of the complete form (22%).

Right Ventriculogram.—The right ventriculogram has always shown a very large right ventricular cavity in which the contrast medium becomes greatly diluted, making its interpretation difficult at times.

Among nine cases of the partial form and common atrium, the presence of an interventricular communication was suspected from the right ventriculogram alone in two cases (22% falsely positive). Conversely, in three of eight cases of the complete form, the interventricular communication was not demonstrated (37% falsely negative). Tricuspid regurgitation has usually been absent in cases of the partial form or common atrium, and present, although mild or moderate, in cases of the complete form.

COMMENT

A fairly uniform appearance of the frontal left ventricular angiogram has been found in cases of the partial form, common atrium, and complete form of persistent common atrio-

ventricular canal of that type in which the anterior common atrioventricular leaflet is divided into two portions attached medially to the septum. This pattern consists of an elongated, narrow, somewhat horizontally inclined, left ventricular outflow tract, best visualized in diastole, and of a peculiar appearance of the right border of the left ventricle, best visualized in systole. The latter consists of a scalloped, serrated contour with a single, deep, nonopaque indentation formed by the coapted portions of the divided anterior mitral leaflet.

In two cases of the complete form in which the anterior common leaflet was not attached to the septum, a different appearance of the left ventricular outflow tract and right ventricular border was noted. In diastole a right-angle pattern was present and in systole the scalloping and the deep notch in the right outline of the left ventricle were absent. An explanation for this angiographic appearance is suggested by the anatomic arrangement of the mitral valve. In the partial form, the two portions into which the anterior leaflet of the mitral valve is divided are attached directly to the interventricular septum. When the undersurface of the two portions is inspected, it is apparent that the attachment to the crest of the muscular septum is by way of a membrane resulting from densely fused, interwoven chordae tendineae. In this area, the chordae are sculptured in the leaflet tissue. It is conceivable that, in the frontal left ventriculogram, the contrast medium trapped under these leaflets may create, in systole, the scalloped appearance and the single, deep, nonopaque indentation at the site where the two portions meet. Analogously, in the complete form, when the anterior common leaflet is divided and the mitral portion is medially attached to the septum by chordae tendineae, an angiographic appearance similar to that of partial atrioventricular canal may result.

When the common anterior leaflet is not attached to the septum but floats freely above it, it is conceivable that during diastole it may be lifted up and displaced more horizontally by the incoming blood, and that in systole, when coapting with the posterior common leaflet, it may, for the same reason, fail to produce the deep single indentation observed in the other types of atrioventricular canal.

If future observation confirms these findings, the left ventriculogram may, among the complete forms of atrioventricular canal, be useful in differentiating those with the anterior common leaflet not attached to the septum from those with the anterior common leaflet divided and attached to

the septum. The latter group is the one most frequently encountered and has a much better surgical prognosis.⁵ It must be emphasized that the presence of the mitral deformities, often seen in postmortem specimens, may create atypical angiographic images and cause error in interpretation. The left ventriculogram alone does not provide clues in differentiating between the partial form, common atrium, and the type of complete form with anterior common leaflet divided and attached to the septum, because of the similar appearances of the right border of the left ventricle and its outflow tract in these types.

The demonstration of an interventricular communication is of course the clue to the differential diagnosis of these forms. Unfortunately, the incidence of false-positive and false-negative diagnoses, as far as the presence or absence of an interventricular communication is concerned, is rather high. Furthermore, the interventricular communication in the complete form is not localized as in a typical ventricular septal defect but occurs in a broad area underneath and between both common leaflets. This adds to the difficulty of a correct angiographic interpretation. In view of this, it is advisable to take a right ventricular angiogram in addition to a left ventricular angiogram in all cases of persistent common atrioventricular canal.

SUMMARY

Twenty-seven left ventricular angiograms were reviewed in 29 cases of persistent common atrioventricular canal in which the intracardiac anatomy had been later described surgically or pathologically. All cases of the partial form, common atrium, and the complete form of persistent common atrioventricular canal with anterior common leaflet divided and medially attached to the septum had a similar appearance on the frontal left ventriculogram. This appearance was that of an elongated and narrow left ventricular outflow tract, best seen in diastole, and that of a scalloped right border of the left ventricle with a deep, single, nonopaque indentation at the site where the two portions of the divided anterior mitral leaflet coapt, best seen in systole. In two cases of complete common atrioventricular canal with anterior common leaflet not attached to the ventricular septum, a peculiar right-angled appearance of the left ventricular outflow tract was present in diastole, while in systole the typical serrated appearance and the deep indentation were absent. The right ventricular angiograms studied in 17 patients were not characteristic.

An interventricular communication was falsely suspected in the left ventricular angiogram in 28% of cases, while it was not demonstrated in 92% of cases in which it proved to be present. In the right ventricular angiogram an interventricular communication was falsely suspected in 92% of cases, while it was not demonstrated in 37% of the cases in which it proved to be present.

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