Angiographic Study of Univentricular Heart of Right Ventricular Type

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SUMMARY  An angiographic analysis of 10 cases of univentricular heart of the right ventricular type is reported. This congenital malformation is characterized by a large chamber with right ventricular morphology that receives both atrioventricular valves, and a second, smaller chamber, a trabecular pouch, with left ventricular morphology. These chambers are separated by a posterior septum but are connected by an inlet septal defect.

The angiographic studies were done using the angled angiographic techniques in three patients and the standard frontal and lateral angiographic views in seven cases. The atrial situs in seven patients was solitus, in one inversus, and in two it was ambiguous with left isomerism. In seven patients the usually large right ventricular chamber received two atrioventricular valves and in four patients, one atrioventricular valve was straddling. Three patients had atresia of one atrioventricular valve.

The trabecular pouch was small in seven patients but relatively large in three. In six patients the trabecular pouch was located posterior and to the left of the right ventricular chamber and in four anterior and to the right. Double outlet right ventricle was present in all cases. The aorta arose anteriorly to the pulmonary artery in nine patients and posteriorly in one.

An autopsy was performed in one case and its correlation with the angiographic findings was remarkable. The angiographic demonstration of the anatomical details of this entity and its associated anomalies was facilitated by angled angiography.

UNIVENTRICULAR HEART is a congenital malformation in which a single ventricular chamber receives the entire atrial outputs, through two atrioventricular valves or a common valve when one valve is absent. Three types of univentricular heart can be identified, depending on the anatomic features of the ventricular chamber receiving the valve or valves: left ventricular type, right ventricular type, and indeterminate type.

Among univentricular hearts, the left ventricular type is the most frequent, the easiest to diagnose angiographically, and from the surgical viewpoint, is most amenable to total correction. The right ventricular type is a rare condition, and although some angiographic studies have been reported, they do not clearly define the anatomy. In this report we analyze the angiographic anatomy of 10 cases of univentricular hearts of right ventricular type seen at the University of Alabama in Birmingham over 8 years.

Definition of Terms

Ventricular Morphology

Univentricular heart of right ventricular type is defined as a ventricular malformation characterized
by a large chamber with the trabeculated pattern of
the right ventricle receiving two atroventricular valves
or, in the absence of one valve, the sole atroventricu-
lar valve. Such hearts usually have a septal
structure that extends toward the crux of the heart. A
rudimentary chamber with the trabecular pattern of
the left ventricle is present, but usually does not have
either inlet or outlet portions. This chamber may be
called a trabecular pouch. In rare circumstances the
rudimentary chamber may have an outlet and is then
termed an outlet chamber. We did not see such hearts
in this study, but they have been described. Cases
without rudimentary chamber were also excluded,
since they cannot be differentiated from the indeter-
minate type with certainty. Cases with absence or
atresia of one atroventricular valve are included in
this study only when an anatomic potential com-
munication between the blind-ending atrium and the
large ventricular chamber is demonstrated, or else
when it was clear that the blind-ending atrium had no
possible potential connection with the rudimentary
chamber.

We use the terms dextrocardia and levocardia to
indicate the position of the cardiac axis independent of
the connections or relation of the heart chambers and
great vessels. The relationship between the main and
rudimentary chamber is described in terms of anter-
posterior, superoinferior and right-left positions.

The atroventricular valves are called right, left or
common, according to their anatomic structure and
their connection with the corresponding atrium. We
avoid the terms mitral and tricuspid because the
morphology of the atroventricular valves in univen-
tricular hearts is usually not similar to that of the nor-
mal valves.

Straddling atroventricular valve is a condition in
which the right or left atroventricular valve overrides
the septum to some degree. We consider the strad-
dling atroventricular valve a transitional stage be-
 tween the biventricular hearts and double inlet. We
assign the straddling atroventricular valve to the
chamber underlying more than 50% of such valve.

The arterial connection establishes the anatomic
relationship between the ventricular chambers and the
great arteries. In this report, since by definition the
arteries are related only to the main chamber, the con-
nexion is either double outlet or single outlet. In cases
in which only one great vessel arises from the heart,
we use the terms single outlet of the heart with pul-
monary atresia or aortic atresia.

Material and Methods

Ten patients who had a main ventricular chamber
with the morphological appearance of right ventricle
and a trabeculated pouch with left ventricular
morphology are the subjects of this study. This
diagnosis was made angiographically. One patient
also had an autopsy study.

Catheterization was performed with the patients un-
der general anesthesia. NIH catheters were intro-
duced from the saphenous vein in seven patients and from
the axillary vein in three.

Figure 1. Selective angiogram of the morphological right
ventricle in a left lateral view (case 2). The catheter was
passed from the left atrium into the right ventricle through
the left atroventricular valve (LAV). The right ventricle
(RV) is a large chamber located anterior to the trabecular
pouch (TP). The right atroventricular valve (RAV) enters
completely into the right ventricle. The LAV straddles the
ventricular septum (clear arrow); most of its annulus (arrowhead) and chordae tendineae (full arrow) insert in the
main chamber (complete form of straddling LAV). The
chordae tendineae to the trabeculated pouch, not seen in the
picture, were seen on the motion picture. The great arteries
arise from the right ventricle with the aorta (AO) anterior
and to the right of the pulmonary artery (PA). An area of
discontinuity between the atroventricular and pulmonic
valves is seen, indicating a well-developed ventriculo-
infundibular fold.

The angiographic study was made by selective ven-
triculography of the main chamber. Selective
opacification of the trabecular pouch was performed in
three patients. Additional selective injections of
contrast media were made beneath the semilunar
valves in three patients in whom the ventriculograms
failed to demonstrate the anatomy of this area.
Renografin-76 (meglumine diatrizoate) was injected by
hand in small children and by power injector in
larger patients. In patients younger than 1 year, 1 ml
of contrast media per pound per injection was used.
Each injection was separated by a 15-minute interval
(the estimated time for clearance of 40% of the con-
trast from the vascular system). In larger pediatric
patients and adults, 40–60 ml of contrast media per injection was delivered at 30 ml/sec.

Frontal and lateral views were used for cineangiograms in seven cases. In three cases, biplane axial angiography was used. The basic axial projections were the “four-chamber” and elongated right anterior oblique views. In our series two of three patients studied with axial angiograms needed three injections of contrast media, and two injections were done in the third patient.

**Angiographic Study**

In the angiographic analysis of the univentricular heart, a specific protocol has been followed: 1) identification of atrial situs and its venous connections; 2) analysis of the number and mode of connection of the atrioventricular valves; 3) analysis of the ventricular anatomy including the rudimentary chamber; 4) analysis of the ventriculoarterial connections; and 5) associated anomalies. In each of these steps, the following angiographic features were considered for the final analysis:

**Identification of the Atrial Situs and Its Connections**

The angiographic features leading to the diagnosis of the atrial situs have been previously reported.

Angiographic demonstration of atrioventricular connections was made using procedures previously reported.

**Analysis of the Number and Mode of Connections of the Atrioventricular Valves**

In the four-chamber view, the angiographic anatomy of the posterior segment of the ventricular septum is usually best visualized and overriding of the atrioventricular valves identified. A double inlet connection is established when two atrioventricular valves were seen to connect the greater part of both atria with the same ventricular chamber. An absent atrioventricular connection (single inlet) is established when one atrium has no direct communication with the rudimentary ventricular chamber. It may have had a potential connection with the main chamber. The right atrioventricular valve is usually higher and more
Table 1. Angiographic Features of Univentricular Heart of Right Ventricular Type

<table>
<thead>
<tr>
<th>Cases</th>
<th>Age</th>
<th>Sex</th>
<th>Heart axis</th>
<th>Situs</th>
<th>AV Valves (number)</th>
<th>Mode of AV connection</th>
<th>Main chamber angiographic anatomy</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>22 mos</td>
<td>M</td>
<td>Right</td>
<td>Inversus</td>
<td>Single</td>
<td>Atresia of the right</td>
<td>Mainly LV pattern (RV pattern in anterior wall)</td>
</tr>
<tr>
<td>2</td>
<td>6 yrs</td>
<td>M</td>
<td>Left</td>
<td>Solitus</td>
<td>Double</td>
<td>Straddling on the left</td>
<td>Mainly RV pattern (LV pattern in posterior wall)</td>
</tr>
<tr>
<td>3</td>
<td>29 mos</td>
<td>M</td>
<td>Left</td>
<td>Solitus</td>
<td>Single</td>
<td>Atresia of the left</td>
<td>Mainly RV pattern (LV pattern in posterior wall)</td>
</tr>
<tr>
<td>4</td>
<td>27 yrs</td>
<td>F</td>
<td>Left</td>
<td>Ambiguous left</td>
<td>Double</td>
<td>Straddling of the right</td>
<td>RV pattern</td>
</tr>
<tr>
<td>5</td>
<td>1 yr</td>
<td>M</td>
<td>Left</td>
<td>Solitus</td>
<td>Double</td>
<td>Straddling of the right</td>
<td>Mainly RV pattern (LV pattern in septal wall)</td>
</tr>
<tr>
<td>6</td>
<td>10 yrs</td>
<td>M</td>
<td>Left</td>
<td>Solitus</td>
<td>Double</td>
<td>Complete connection with RV</td>
<td>Mainly RV pattern (LV pattern in inferior wall)</td>
</tr>
<tr>
<td>7</td>
<td>3 yrs</td>
<td>F</td>
<td>Right</td>
<td>Solitus</td>
<td>Double</td>
<td>Complete connection with RV</td>
<td>Right ventricular pattern</td>
</tr>
<tr>
<td>8</td>
<td>4 yrs</td>
<td>F</td>
<td>Left</td>
<td>Solitus</td>
<td>Double</td>
<td>Straddling of the left</td>
<td>Right ventricular pattern</td>
</tr>
<tr>
<td>9</td>
<td>11.5 yrs</td>
<td>M</td>
<td>Left</td>
<td>Solitus</td>
<td>Double</td>
<td>Complete connection with RV</td>
<td>Mainly RV pattern (LV pattern in posterior wall)</td>
</tr>
<tr>
<td>10</td>
<td>5 yrs</td>
<td>F</td>
<td>Right</td>
<td>Ambiguous left</td>
<td>Single</td>
<td>Atresia of the left</td>
<td>Mainly RV pattern (LV pattern in posterior wall)</td>
</tr>
</tbody>
</table>

Abbreviations: AV = atrioventricular; PA = pulmonary artery; AVV = atrioventricular valve; AO = aorta; Assoc Anom = associated anomalies; RV = right ventricle; LV = left ventricle; Discont. = discontinuity; Cont. = continuity; VIF = ventricular infundibular fold; PS = pulmonary stenosis; ASD = atrial septal defect; LSVC = left superior vena cava; RVI = right valve insufficiency; ARPA = absence of right pulmonary artery.

anterior than its counterpart. In some cases, however, it is in the same sagittal plane. Straddling right or left atrioventricular valves are established when the annulus alone or the annulus and the peripheral apparatus are inserted in both sides of the septum (fig. 1). The angiographic demonstration of leaflets and chordae tendineae is more easily visualized on motion picture than on single frame. The valves can be identified by a negative shadow during diastole that encroaches on the contrast containing the trabecular pouch and the large ventricular chamber. When the atrioventricular connection is made through a single valve, such a valve may consist of a large common atrioventricular valve or a well-developed right valve with absence of the left valve or vice versa (fig. 2). The distinction between a single atrioventricular valve (absence of one atrioventricular connection) and a common atrioventricular valve can be made by cineangiographic study: The common atrioventricular valve is connected with both atria and its two functional leaflets open and close in an "eyelid" fashion perpendicular to the ventricular axis.

Figure 4. Right ventriculogram in four-chamber view (A) and right anterior axial oblique view (B). A) Case 9. The right ventricle (RV) is a large chamber receiving the right and left valves (RAV and LAV). Discontinuity between the aortic and atrioventricular valves is seen. The aorta (AO) obscures the pulmonary artery, which is small. The trabeculated pouch is not seen in this view. B) The RV is seen in profile. The atrioventricular valves are superimposed; the RAV is higher than the LAV. The trabecular pouch (TP) is seen in profile attached to the inferior part of the right ventricle.
Table I. (Continued)

<table>
<thead>
<tr>
<th>Trabecular pouch</th>
<th>Ventriculoarterial connection</th>
<th>PA-AVV relationship</th>
<th>AO-AVV relationship</th>
<th>Aortic Arch</th>
<th>Assoc Anom</th>
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</thead>
<tbody>
<tr>
<td>Posterior left</td>
<td>Double outlet</td>
<td>Discont.</td>
<td>Cont.</td>
<td>Left</td>
<td>PS</td>
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<tr>
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<td>Double outlet</td>
<td>Discont.</td>
<td>Discont.</td>
<td>Left</td>
<td>ASD</td>
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<td>Double outlet</td>
<td>Discont.</td>
<td>Discont.</td>
<td>Left</td>
<td>PS, LSVC</td>
</tr>
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<td>Discont.</td>
<td>Discont.</td>
<td>Right</td>
<td>PS, RVI</td>
</tr>
<tr>
<td>Inferior right</td>
<td>Double outlet</td>
<td>Discont.</td>
<td>Discont.</td>
<td>Left</td>
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<td>PS, ASD, ARPA</td>
</tr>
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<td>Posterior left</td>
<td>Double outlet</td>
<td>Discont.</td>
<td>Discont.</td>
<td>Left</td>
<td>PS, ASD</td>
</tr>
</tbody>
</table>

Analysis of the Ventricular Anatomy
Including the Rudimentary Chamber

The morphology of the main chamber is identified according to the trabecular pattern as either right or left. When the trabeculation pattern is not clearly left or right type, the ventricle is called indeterminate.17

The main chamber usually is a large, bulbous structure with a rounded apex. The trabeculations are heavy in most cases, but they are not distributed uniformly. Fine trabeculations primarily of the posterior and inferior walls suggest an undifferentiated type of ventricle. However, when a trabecular pouch with left ventricular type trabeculations is present as a separate

![Figure 5. Right ventricular angiograms of two patients obtained on lateral (A) in one patient and long-axis (B) views in the other. A) Case 5. The right ventricular chamber (RV) is the largest chamber located anterior to the trabecular pouch (TP). The right atrioventricular valve was not visualized in this angiogram. The left atrioventricular valve (LAV) connects the left atrium with the main chamber. Part of the annulus and leaflets of the LAV are in contact with the TP, indicating a complete form of straddling valve. The great arteries arise from the main chamber, with the aorta (Ao) anterior to the pulmonary artery (PA). A short infundibular septum (IS) separates the subaortic and subpulmonic portions of the right ventricular outflow tract. B) Case 1. The RV is anterior to the TP. The left LAV connects the left atrium with the ventricle. There was absence of the right atrioventricular valve. The TP is a small posterior chamber connected with the ventricle through a small septal defect (sd) that is located near the aortic valve. There is continuity between the LAV and Ao. The great arteries arise from the ventricle in a normal relationship, with the PA anterior and to the left of the Ao.](image-url)
chamber, it makes the right ventricular domination unequivocal. A group of large trabeculations may be present at the posterior wall of the right ventricle, forming a posterior ridge; this structure may be incorrectly interpreted as a ventricular septum, resulting in an erroneous diagnosis of a heart with three "ventricular" chambers (fig. 3). The trabecular pouch of left ventricular type is seen as a ventricular chamber similar to those of a normal left ventricle with a smooth wall adjacent to and connected with the main ventricle (figs. 1, 4B, 5–7).

Analysis of the Ventriculoarterial Connection

This connection is easy to establish angiographically. The great arteries arising from the heart may have several interrelations, as reported by several au-

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**Figure 6.** Selective angiogram of the trabecular pouch (TP) in patient 5. A) Systolic and B) diastolic frames. The catheter has been passed from the left atrium into the ventricle (RV) and then into the TP through a septal defect. The left atrioventricular valve (LAV) connecting the left atrium with the ventricle is partially in relation with the TP (arrowhead). A segment of the annulus crosses the septal defect (clear arrows) and enters into the TP, indicating straddling valve. The tensor apparatus and leaflets not seen here were identified easily on motion picture. Notice that the concentration of the opaque material in the TP is higher than in the ventricle. The pulmonary artery (PA) and aorta (AO) are also well opacified in contrast to the ventricle. This diastolic angiographic appearance, in which the TP and the great arteries are heavily opacified in contrast to a poorly outlined ventricle, has been found consistently in patients with univentricular heart of right ventricular type.

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**Figure 7.** A) Early and B) late angiogram of the trabecular pouch (TP) in right anterior oblique view (case 8). The TP is a large chamber with smooth borders similar to a normal left ventricle. The catheter has been passed from the right atrium into the ventricle and then into the TP through a septal defect (arrowhead in A). Another ventricular septal defect is seen near the apex (arrowhead in B). The right ventricular main chamber (RV) is located superiorly and to the left of the trabecular pouch. C) Systolic and D) diastolic selective angiograms of the morphological right ventricular chamber in four-chamber views from the same patient are shown. Selective opacification of the right portion of the ventricle is seen in C. The right atrioventricular valve (RAV) connects this chamber with the right atrium. There is partial opacification of the left portion of the ventricle related with the left atrioventricular valve (LAV). A large ostium infundibulum (oi) connects the two portions of the ventricle. A septal defect (sd) is visualized connecting the RV to the TP, which lies inferiorly and to the right of the RV. Selective opacification of the left portion of the RV is shown in D. The catheter was passed from the right to the left portions of the main chamber through the ostium infundibulum. The LAV, which joins the left atrium with the right ventricle, is posteriorly located. The great arteries arise from the RV. The aorta (Ao) originates from the right anterior part of the ventricle and the pulmonary artery (PA) originates from the left and posterior. The ascending Ao is located anteriorly and to the left of the PA. The arterial valves are separated from the atrioventricular valves by large ventriculo-infundibular fold (VIF). The large infundibular septum (IS) is oriented anterior and to the left and divides the right ventricular outflow tract in the subaortic and subpulmonary portions.
The position and level of the arterial valves are best seen in the diastolic phase (figs. 5A and 5B). Particular attention must be taken in studying the continuity between the arterial and atrioventricular valves (figs. 7 and 8).

**Associated Anomalies**

Associated anomalies should be mentioned in order of importance.

**Results**

A summary of the angiographic features of our 10 cases is shown in table 1. There were six males and four females in the series. The age range was from 22 months to 27 years. Seven cases had a situs solitus of the atria, one had a situs inversus and the other two cases had a situs ambiguous (left isomerism).

Two atrioventricular valves were present in seven cases (figs. 1, 3, 4 and 7), the left atrioventricular valve
FIGURE 8. Anatomic appearance of the case shown in figure 7 (case 8). A) Anterior view of the main chamber in its right portion. The bivalved right atrioventricular valve (RAV) connects the right atrium (RA) and morphological right ventricular chamber (MRV). The ostium infundibulum (OI) is the connection between the right and left portions of the chamber. There is a muscular septal defect (sd) located posteriorly near the crux of the heart, which connects this chamber with the trabecular pouch (TP) seen in C. A large ventriculoinfundibular fold (VIF) separates the RAV from the aorta (Ao). The infundibular septum (IS) forms the left wall of the subaortic outflow tract. Inlet (B) and outlet (D) segments of the left portion of the ventricle are shown. The left atrioventricular valve (LAV) connects this chamber with the left atrium (LA). A muscular septal defect connects the morphological MRV with the TP as seen in C. The outlet segment of this part of the ventricle is formed by a large VIF posteriorly, by the IS in its right aspect and by the free wall anteriorly. A large papillary muscle supports the anterior leaflet of the LAV. The left aspect of the OI is seen beneath the IS. The pulmonary valve originates entirely from the right ventricle and it is in discontinuity with the LAV. A short segment of this valve straddles the posterior septum (SV). C) Inferior view of the TP. The free wall has been lifted for better exposure. The walls are smooth similar to the normal left ventricle. No atrioventricular valve is seen entering this chamber. The trabecular septum (TS) makes up the superior wall of the TP. Two muscular septal defects were identified. The superior is connected with the right part of the ventricle as seen in A. The inferior septal defect is in connection with the left part of the ventricle as seen in B. There is a third septal defect in the left corner surrounded partially by fibrous tissue of the LAV. Chordae tendineae pass from the ventricle into the TP (arrowhead), indicating a peripheral form of straddling LAV.
was absent in two cases and the right atrioventricular valve was absent in the other case (fig. 5B). Two right and two left atrioventricular valves were straddling the ventricular septum (figs. 1, 5A and 6). The angiographic features of the main chamber were as follows: 1) The inlet portion just beneath the atrioventricular valves was heavily trabeculated and similar to a normal right ventricle in all cases (fig. 4A). 2) The trabeculated portion was, in nine out of 10 cases, similar to a normal right ventricle except at the level of the posterior wall in which a left ventricular pattern was present (fig. 4B). In the tenth case, a left ventricular trabeculation pattern was present throughout most of the main chamber except for a small segment of the anterior wall (fig. 5B). 3) The outlet portion was usually large and gave rise to the aorta and the pulmonary artery in all of our cases (figs. 4 and 5A).

The infundibular septum was identified separating the subarterial segments (figs. 7C and 7D). In one out of 10 cases, the infundibular septum fused shortly after its origin from the anterior wall, giving the appearance of an anterior rudimentary chamber (fig. 5B).

The trabecular pouch was posterior and to the left in six cases (figs. 1, 5A, 5B, 6A and 6B). In the other four cases, it was inferior and to the right (figs. 7A and 7B). The size of the trabecular pouch was highly variable, and was rather small in seven cases. A common denominator for all the cases was the angiographic appearance of the trabecular pouch walls, all of which were smooth and of a left ventricular pattern (figs. 5A, 5B, 7A and 7B). No papillary muscles were seen in the trabecular pouch.

Regarding the ventriculoarterial connections, the aorta and the pulmonary artery were present in all cases and originated from the main ventricular chamber, fulfilling the requirements of a double outlet right ventricle. The aortic valve was discontinuous from the atrioventricular valves in nine of the cases. The pulmonary valve was also discontinuous in nine cases. Therefore, in most cases, the arterial valves were supported by infundibular musculature separating them from the atrioventricular valves (figs. 7C and 7D).

The interrelation between the great arteries was as follows: In nine cases, the aorta and the pulmonary artery were at the same level in the craniocaudal plane; in the tenth case, the aorta was caudal to the pulmonary artery (fig. 5B). In the frontal plane, the aorta was anterior and to the left in five cases, anterior and to the right in four cases, and directly posterior in one case (table 1). The aortic arch was to the left in nine cases and to the right in the tenth case.

The most important associated anomalies in the series were: pulmonary stenosis — seven cases; atrial septal defect — six cases; left superior vena cava — one case; absence of right pulmonary artery — one case.

The angiographic pattern in this series was a densely opacified trabecular pouch and the great arteries in the presence of a poorly opacified main chamber during diastolic phase. This usually gives the appearance of two dense areas separated by a clear zone (figs. 6A, 6B, 7A and 7B). The main ventricular chamber thus cleared rapidly with the arrival of non-opacified blood from both atria. One case (patient 8) died after an attempt at surgical correction. The angiographic study (fig. 7) showed: 1) Solitus of the atra, 2) univentricular heart with two atrioventricular valves entering the morphological right ventricle, 3) trabecular pouch with left ventricular morphology located inferiorly and to the right, 4) double outlet right ventricle with aorta anterior and to the left, 5) pulmonary stenosis, and 6) atrial septal defect. A summary of the pathologic findings is as follows (fig. 8): 1) solitus of the atra, 2) large ventricular chamber with right ventricular morphology divided by the infundibular septum in two portions, 3) trabecular pouch with left ventricular morphology located inferior and to the right, 4) straddling left atrioventricular valve, 5) double outlet right ventricle, 6) well-developed ventriculo-infundibular fold under each arterial valve, and 7) aorta anterior and to the left.
Discussion

Different terminology has been used to define univentricular heart of the right ventricular type. Van Praagh and colleagues reported three cases of single ventricle with well-developed morphological right ventricle in absence of left ventricular sinus (type B). Muñoz-Castellanos called this malformation double inlet right ventricle and Quero-Jimenez, after an embryological study, identified it as an exaggerated displacement of the atroventricular canal toward the bulbus cordis. Keeton et al. introduced the term univentricular heart of right ventricular type, pointing to the fact that the left ventricular chamber was directly comparable with the rudimentary chamber seen more frequently in “single ventricle with outlet chamber.”

Previous reports of angiographic studies have failed to demonstrate this type of univentricular heart.

The angiographic identification of the anatomy in univentricular heart of right ventricular type has been facilitated in our last three cases by axial angiography developed by Bargeron et al. With this technique, the ventricular main chamber (right ventricular type) can be visualized in some aspects that are not easily seen in conventional frontal and lateral views, such as straddling valves, chordae tendineae, and trabecular pouch.

In three of our 10 cases, one atroventricular valve was absent. These particular cases have been called by others tricuspid or mitral atresia, but we prefer to use the term of Anderson et al. and call them univentricular hearts, and specify which connection is absent.

The diagrams in figure 2 were made to clarify this complex cardiac malformation. We do not propose a new classification. Although there was no case with common atroventricular valve in our series, we included it in the scheme because it is possible.

In the case in which an autopsy was performed, a very small and rudimentary papillary muscle was found in the trabecular pouch. This probably accounts for our failure to identify such structures in the cineangiography of this chamber. During cineangiography the trabeculated pouch remained opacified longer than the main ventricular chamber because of the relatively restricted septal defects that preclude free blood interchanges between the main chamber and trabecular pouch, and because, unlike the trabecular pouch, the nonopacified blood from the atria washes out the contrast media rapidly from the main chamber. The angiographic image at this stage is such that the opacified trabecular pouch and the opacified great arteries seemed to be separated from each other by the clear zone that represents the main ventricular chamber.

We believe that this type of univentricular heart can be diagnosed angiographically by its peculiar angiographic appearance. The main ventricular chamber that receives the two atroventricular valves has the angiographic features of a normal right ventricular chamber and the presence of the trabecular pouch (rudimentary chamber) with left ventricular morphology makes certain the unequivocal diagnosis of univentricular heart of the right ventricular type.

Acknowledgment

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