as an acoustic stethoscope would be used, and not a replacement for traditional echocardiography. For this reason, in our unit we use the term "ultrasound stethoscope" to describe a miniature hand-held echocardiographic device.

In summary, the hand-held 2-dimensional ultrasound device, used as part of the standard history and physical examination by trained personnel, can provide structural and functional information that may influence diagnosis and management, often more efficiently than routine echocardiography.

**Origin of the Left Main Coronary Artery from the Pulmonary Trunk in the Syrian Hamster**

Valentín Sans-Corra, PhD, José M. Arqué, MD, Ana C. Durán, and Manuel Cardo

In an ongoing experimental study of congenital coronary arterial anomalies in the Syrian hamster, carried out in our laboratory, 6 cases (2 male, 4 female) have been detected in which the left main coronary artery originated from the pulmonary trunk and the right coronary artery from the aorta. This anomaly is well known in human patients, but only 1 reference could be found for other mammals.

Until now, 654 hamsters have been examined using a corrosion casting technique. A vinyl resin in a 20% ketone solution was injected by means of a cannula placed in the ascending aorta through the apex of the left ventricle. The right ventricle and the pulmonary trunk also were injected. The internal cast of the ventricles and arterial vessels was obtained by macerating the specimen in a hydrochloric acid bath. The hamsters belonged to a complex of 19 breeding colonies originated from a group of 9 males and 14 females. The colonies were subjected to high endogamous pressure by mating animals of the same litter.

A considerable proportion (10.1%) of the animals examined revealed coronary arteries with anomalous origin unassociated with major anomalies of the great vessels or macroscopic anomalies of the heart. Eight percent were specimens with single coronary artery and 1.2% with single coronary artery from the left aortic sinus (Table I). In some colonies the endogamous breeding continues increasing these anomalies, which will be the subject of a future publication. The 6 cases presented in this report concern the remaining 0.9%. All 6 affected hamsters survived the postpartum period without difficulty and were killed at different ages (between 15 and 132 days), according to the experimental plan. Four animals (1 male, 3 females) had attained sexual maturity, 1 female was in early puberty (32 days) and the remaining male was still immature (15 days). Their coefficients of inbreeding ranged between 0.250 and 0.500. However, each belonged to a different breeding colony, so they were quite remotely related.

Specimens with single coronary artery were detected in each one of the 6 concerned breeding colonies. The mean percent frequencies of this anomaly ranged between 3.3 and 24.7% in these colonies (Table I). However, only 3 of the 6 hamsters had direct ancestors, either near or distant, with single coronary artery (specifically, from the right aortic sinus). In one case it was a mother and great-grandfather, in another a father, mother and great-grandmother and in the third case 2 great-great-grandparents. Four of the 6 hamsters had siblings with a single coronary artery from the right aortic sinus and 2 of these did not have an anomalous direct ancestor.

In every case, the right coronary artery was dilated, rather tortuous and originated from the right aortic sinus.

**TABLE I Frequency of Arterial Coronary Anomalies in the Breeding Colonies**

<table>
<thead>
<tr>
<th>Colony</th>
<th>Gns</th>
<th>No. (n = 654)</th>
<th>LCAPT</th>
<th>SCALAS</th>
<th>SCARAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-XIX</td>
<td>1-5</td>
<td>119</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>0.9</td>
<td>1.2</td>
<td>1.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Gns = number of endogamous generations reached in the colony; LCAPT = left coronary artery from the pulmonary trunk; SCALAS = single coronary artery from the left aortic sinus; SCARAS = single coronary artery from the right aortic sinus.

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nus, whereas the left main coronary artery arose from the left pulmonary sinus. Anastomoses had developed between them. A study of the main morphologic features of these anastomoses revealed 4 different types.

**Type 1 (3 cases):** The right coronary artery runs parallel to the right atrioventricular sulcus, becoming intramyocardial shortly after its origin. It crosses the diaphragmatic wall of the heart to reach the obtuse margin, where it connects with the left coronary artery (Figure 1).

**Type 2 (1 case):** The unusually well-developed acute marginal branch of the right coronary artery reaches the apex of the heart to connect there with the obtuse marginal branch of the left coronary artery. It should be pointed out that in the hamster the obtuse marginal branch is normally the principal branch of the left coronary artery (Figure 2).

**Type 3 (1 case):** The posterior descending branch of the right coronary artery gives rise to 2 parallel vessels which run within the posterior wall of the left ventricle to reach the obtuse margin. At this level, both vessels connect with the left coronary artery (Figure 3).

**Type 4 (1 case):** The posterior descending branch of the right coronary artery gives off a septal perforating branch that reaches the anterior wall of the left ventricle to connect there with the left coronary artery (Figure 4).

The anomalous origin of the left main coronary artery from the pulmonary trunk in the hamster reported in the present study corresponds to the adult type of this anomaly in human subjects. The other extreme manifestation...
of this anomaly (not found in hamsters) is characterized in humans by the absence of a collateral circulation (infantile type). Although in the hamster the coronary arteries run intramyocardially, the different arrangements of the coronary anastomoses found in this species are remarkably similar to 4 of the 5 types mentioned by Neufeld and Schneeweiss in human subjects.

The present observations suggest that the development of intercoronary anastomoses in the hamster must be completed very early after birth, or even before birth, because at the age of 15 days the connection between both coronaries was fully established.

From the morphogenetic point of view, the coexistence in the hamster of a right coronary artery from the right aortic sinus and a left main coronary artery from the left pulmonary sinus agrees with the theory explained by Hackensellner and confirmed by Conte and Pellegrini in human subjects. The fact that the present findings were obtained in a rodent species belonging to a phylogenetically low mammalian group strongly supports the assumption that this sinusal capability may be the rule in mammals. For other mammals, however, there is no information at present proving that the morphogenetic development of the trunk of their coronary arteries follows the same steps as those demonstrated by Conte and Pellegrini in human subjects.

The high frequency of specimens with single coronary ostium in aorta found in the inbred colonies studied, together with the further increase of this frequency observed in some lines as homozygosis increases because of the endogamy, already suggest that genetic factors contribute to the development of malformations of this kind in the hamster. As was explained, all specimens with a left main coronary artery arising from the pulmonary trunk were obtained from matings between siblings. Moreover, all the specimens with this anomaly had near or distant relatives with single coronary ostium in aorta. These facts further suggest, in agreement with the morphogenetic theory of Hackensellner, that the different arrangements of the coronary arteries as they originate either from the aortic or from the pulmonary sinuses are a phenotypic set, subordinated to a complex mode of inheritance. However, it is still too early to advance a hypothesis about any specific genetic pattern. More breeding experiments will be necessary to elucidate this question.