An S-Shaped Atrial Artery Supplying the Sinus Node Area*
An Anatomical Study

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An S-shaped sinus node artery (SSNA), originating in the posterolateral part of the left circumflex artery (LCir) below or behind the left auricle, is described in detail. The coronary vessels were studied in 300 human hearts by x-ray films or by casting of the vessels, and the SSNA was found in 24 (21.5 percent) of the 111 cases where the sinus node artery (SNA) arose from the LCir, (ie, 8 percent of all the hearts.) The SSNA constituted a branch of the LCir in 15 cases, the upper part of a divided LCir in 6 cases, and the main continuation of this artery in 3 cases, always following basically the same route to the sinus node (SN) area. It was larger than the normal SNA, supplying the SN and surrounding area, almost the whole left atrium, a large part of the interatrial septum and right atrium, and partially supplying the atrioventricular node area.

Detailed knowledge of the blood supply to the sinus node (SN) area is necessary today because of the wider practice of cardiac surgery, and also for a better understanding of the disturbances of its function caused by coronary disease.

James and Burch1 and James2 report that the sinus node artery (SNA) originates in the right coronary artery (RCA) in 61 percent and 54 percent of cases, respectively, and from the left circumflex artery (LCir) near its origin in 39 percent and 42 percent, respectively. Apart from these, cases have been reported where the sinus node artery is a branch of the posterolateral part of the LCir.14 It is of interest that no consensus of opinion has yet been reached as to the frequency of occurrence of these cases, the type of origin of such an artery, or its route.

In this work, we have tried to resolve these questions by studying a large sample of postmortem cases, a significant number of which had an S-shaped sinus node artery (SSNA) arising in the posterolateral part of the LCir, and supplying, as main atrial artery, the SN and the atrial myocardium.

**Material and Methods**

The study was carried out on a series of 300 human hearts. Death was due to accident in 217 cases, cardiovascular disease in 62 cases, and various other causes in the remaining 21 cases. Of the hearts examined, 211 were from male, and 89 from female subjects, while the average ages were 44 and 48, respectively. The heart weight ranged from 70 to 730 g with an average of 375 g.

To study the coronary vessels, the following two methods were used: (a) radiopaque medium (Ba-Sulfate) was injected at a pressure of 100 to 160 mm Hg, depending on the size of the heart. The x-ray films were taken from different angles of the whole heart and of the atria alone, the heart having been cut along the atrioventricular sulcus (240 cases). (b) The coronary arteries were exposed by our own corrosion casting technique,10 using polyester as the injection material under a pressure of 180 to 280 mm Hg, again depending on the size of the heart. The corrosion material used was concentrated hydrochloric acid (60 cases).

**Results**

In the 300 cases studied (266 right dominant type, 28 left dominant type and 8 balanced type) the SNA arose from the RCA in 185 cases (62 percent), from the LCir in 111 cases (37 percent), and from both coronary arteries in 4 cases (1 percent). The terms “left dominant,” “right dominant” and “balanced” are here used in a topographical sense, according to the artery (RCA or LCir) from which the posterior descending artery originates. In balanced hearts, two descending arteries were present, one a branch of the LCir and the other, larger artery, a branch of the RCA.

The SSNA was found in 24 of the 111 cases where the SNA arose from the LCir, comprising 17 (8 percent) of the male hearts and 7 (7.9 percent) of the female hearts. Of the 286 cases of the right dominant type, 21 (7.9 percent) had the SSNA; of the 28 left dominant types, 3 (10.7 percent) had the SSNA. The SSNA was not found in any of the six cases of the balanced type.

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CHEST, 78: 2, AUGUST, 1980
The SSNA originated from the posterolateral part of the LCir, below or behind the left auricle, and at a distance of 14 to 60 mm (average 38 mm) from the origin of the LCir. It constituted a branch of the LCir in 15 cases (Fig 1 and 2), the upper part of a divided LCir in 6 cases (Fig 3), and the main...
From its origin, the SSNA curves slightly upwards and backwards to a point on the lateral or posterolateral wall of the left atrium at a distance of 7 to 34 mm (average 19 mm) from the origin (section 1). Branches arise along its length, supplying blood to the lateral wall of the left atrium and sometimes to the posterior wall of the left atrium and left auricle.
depending on the point of origin and the length of this section. Along this section, the artery sometimes connects with branches of a small atrial artery whose origin is in the anterior part (proximal) of the LClr. The SSNA then turns sharply and runs forward, still rising, passing below the lower left pulmonary vein. (From the point where it turns, in 17 cases [70 percent], a large branch ran back, parallel to the atrioventricular sulcus, supplying the posterior part of the left atrium, the atrioventricular node area, the posterior interatrial septum, and sometimes part of the posterior right atrium. In the other seven cases [30 percent], the branch distributed only to the posterior part of the left atrium.) The SSNA then curves upwards across the left surface of the left atrium, passing between the pulmonary veins and the left auricle and arriving on the upper surface of the left atrium at the interatrial septum, level with the superior vena cava. The length of this section (section 2) is 45 to 66 mm (average 54 mm). Branches distribute to the pulmonary vein area and to the lateral and anterior wall and roof of the left atrium. It connects with small branches from the anterior part of the LClr. The artery then passes back along the upper part of the interatrial septum, ending in the SN area (9 cases) or continuing along the posterior interatrial septum to end in the posterior right atrium (15 cases). This section (section 3) is from 20 to 40 mm in length (average 29 mm). From this final section, branches travel clockwise and counterclockwise around the superior vena cava to distribute to the SN and surrounding area; from the other side, branches take blood to the upper and sometimes the posterior part of the interatrial septum and to both sides of both atria. This section of the SSNA connects with small branches from the anterior, intermediate, and posterior parts of the RCA.

The route of the SSNA sometimes lies on the epicardium, sometimes passes under the endocardium, and sometimes through the atrial myocardium. Its length from its origin to the SN area ranged between 75 and 110 mm (average 88 mm), while its overall length varied from 87 to 125 mm (average 104 mm), the difference being due to cases where the artery ended away from the SN area.

The inner diameter of the SSNA was measured at a point 5 mm from its origin and was found to be between 0.9 mm and 1.4 mm (average 1.2 mm).

**Discussion**

The three types of origin of this artery, (as a branch, upper division, or continuation) are here described in detail. The distance of the origin of the SSNA from the origin of the LClr depends on the type of origin, as well as on the size of the heart. These different points and types of origin could explain the discrepancies between the descriptions given by previous authors. In Figure 1, the SSNA arises as a branch of the LClr and has a short first section. This type conforms closely to the description given by Gross of a "lateral" SNA. In Figure 2, the SSNA is again a branch of the LClr, but this type has a much longer first section. This fits with James and Burch's description of an "unusual" type of SNA. In Figure 3, the SSNA is the upper part of a divided LClr, whereas, in Figure 4, the SSNA represents the main continuation of the LClr; neither of these types of origin of the SSNA has ever been described for the SNA. Other descriptions by previous investigators of the SNA originating below or behind the left auricle could be interpreted as examples of the SSNA having different types of origin and configurations.

The frequencies of origin of the SNA from the RCA and LClr agree with the findings of previous investigators.

We found the SSNA in 24 of the 111 left origins studied. This proportion (21.5 percent) agrees with the proportion (20 percent) reported by Campbell but is higher than those of James and Burch, James, Romhilt et al., or Kennel and Titus, who report 13 percent, 2 percent, 10 percent, and 9 percent, respectively. These figures suggest that the presence of the SSNA is a relatively common occurrence.

The route of the SSNA, as reported here in detail, is basically the same as was reported by Spalteholz and James and Burch, although the latter described the artery as passing between the pulmonary veins rather than around in front of them, as we found. It is worth noting that the SSNA forms a large ring around the pulmonary veins and, with its special route, can function as a bridge between the two major coronary trunks (RCA and LClr) which lie in the atrioventricular sulcus. This is particularly important in cases where the LClr is occluded near its origin by atherosclerotic disease; the SSNA can then route blood from the RCA to supply the distal part of the LClr. The large distance of the origin of the SSNA from the origin of the LClr (as compared with the usual region of origin of an SNA) also means that the SSNA itself is less likely to be blocked by atherosclerosis, as the occlusion more often occurs in the first few centimeters of the LClr. This, together with the fact that the SSNA can receive blood from the RCA, means that the SN area in a heart with the SSNA is much less vulnerable to atherosclerotic disease than would be the case otherwise.

The length of the SSNA from its origin to the SN...
was, as would be expected, greater than lengths previously recorded for the SNA,\textsuperscript{4,11} \textit{i.e.}, 60 to 80 mm. The variation in length again depends on the type of origin of the artery and on the size of the heart.

The inner diameter of the SSNA as described above was consistent with previous findings for the SNA.\textsuperscript{8,12}

In hearts of the left dominant type, the SSNA can only arise as a branch of the LCir, as the latter artery travels back to become the posterior descending artery.

The frequency of occurrence of the SSNA appears to be irrespective of sex.

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