Anatomical variations of the coronary arteries: I. The most frequent variations

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INTRODUCTION

Today, with the widespread use of new image diagnosis techniques and the development of non-aggressive treatments, a thorough knowledge of the normal coronary anatomy and its variations and/or anomalies is essential. (McConnell et al, 1995; Post et al, 1995; Bunce and Pennell, 2001; Ropers et al, 2001). Failure to distinguish between normal and anomalous structures may lead to misinterpretations and disastrous complications during heart surgery.

The term "normal coronary anatomy" refers to the structures that are habitually observed. The term "anomaly" is used for variations that occur in less than 1% of the general population (Angelini et al, 1999). In this article we will describe the most prevalent variations of the coronary arteries, that is, those with a frequency over 1%.

NORMAL CORONARY ANATOMY

The coronary arteries are the first vessels that branch from the aorta, normally originating below the junction between the bulbus and the ascending aorta, that is, at the sinotubular junction. The coronary orifices are located in the center of the corresponding aortic sinuses and slightly above the free margin of the cusp. Each of the coronary arteries branches off from the aortic wall at a different angle: the right coronary artery usually at 90º, and the left coronary artery at a slightly lower angle (Zamir and Sinclair, 1988) (Figure 1).

The coronary arteries are vessels located in the epicardium, although they may penetrate into the myocardium for part of their route The epicardial vessels finally penetrate into the myocardium and then act as resistance or distribution vessels. Here they form a dense network which is usually connected to the venous circulation via the cardiac capillaries and occasionally with the cardiac cavities (arterio-cameral connections). There are also interarterial coronary connections, described for first time in 1649 by Lower, between different branches of the same coronary (homocoronary collateral circulation) or between different coronary arteries (heterocoronary colateral circulation) (Cohen, 1985).

The heart may receive perfussion not only from the coronary arteries but also from the bronchial arteries, the internal thoracic artery, and the mediastinal vessels. This may explain the high clinical tolerance reported in some cases of coronary artery disease (Hudson et al., 1932; Björk, 1966; Moberg, 1968).

Left coronary artery

The left coronary artery commonly originates in a single orifice situated at the level of the left aortic sinus. Its length is variable, though it is not usually more than a few millimeters. From its origin, it passes behind the outlet of the right ventricle and below the left appendage. Normally, the left coronary artery bifurcates into the anterior interventricular artery and circumflex artery.

The anterior interventricular artery is also known as the anterior coronary artery of Vieussens, the descending anterior coronary
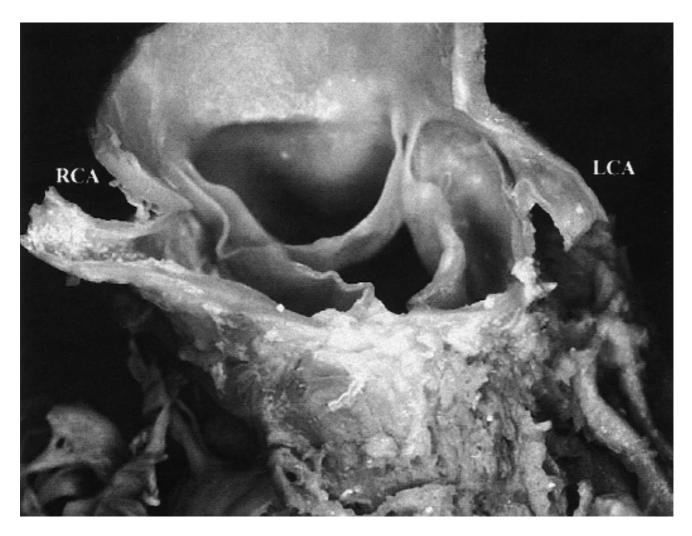
Figure 1. Frontal view of the sinotubular region, showing the different angles of the origin of the coronary arteries, with respect to the aorta wall. (LCA: left coronary artery; RCA: right coronary artery). x 3.5.

artery, or the anterior division of the left coronary artery. It originates in the retropulmonary portion of the left coronary artery, passes above the interventricular groove, adopting an S shape, and in most cases reaches the apex on the right hand side. It occasionally continues through the posterior interventricular groove, where it is known as Mouchet's posterior recurrent interventricular artery.

The circumflex artery or the posterior division of the left coronary artery varies more in terms of its length and distribution. From its beginning, it passes below the left appendage and continues above the left atrioventricular groove, occasionally reaching the diaphragmatic surface. During its course it may reach the left atrium and the posterior atrioventricular groove; in this case it passes below the coronary sinus.

Right coronary artery

The right coronary artery arises from a single orifice in the right aortic sinus. In the first millimeters it is submerged in the adipose tissue of the epicardium below the right atrial appendix (the Rindfleisch fold). It passes above the right atrioventricular groove, and commonly reaches the posterior interventricular groove, frequently passing above the *crux cordis*.

Coronary predominance or dominance

While the irrigation of the sternocostal surface of the heart is extremely regular, the inferior or diaphragmatic surface is supplied by the circumflex and right coronary arteries. This gives each heart its own distinctive physiognomy. The term right or left "coronary preponderance" or "dominance" is used to show which coronary irrigates the heart's diaphragmatic surface (Schlesinger, 1940). This term is frequently used but is potentially misleading; it could be taken to mean that the dominant coronary is the one that irrigates the greater part of the myocardium, but in fact it is always the left coronary artery that does so. The term refers to the supply of the heart's diaphragmatic surface, which may be the right or left coronary.

VARIATIONS IN THE POSITION OF THE CORONARY ORIFICES

Angle of origin

The most frequent variations in the origin of the coronary arteries with regard to the aorta wall are mainly observed in cross-section (Angelini, 1989). The coronary arteries branch off from the aorta wall at a variety of angles: 90º (perpendicular origin), < 90º (tangential origin), or practically 0º (intussusception). In the latter case, small portions of the coronary arteries are embedded in the aortic wall (known as intramural course) (Sacks et al., 1976; Gittenberger et al., 1986).

Situation of the coronary orifices

The situation of the coronary orifices in the aortic sinuses varies, both cross-sectionally and frontally.

In the cross-sectional plane, the left coronary orifice may originate in the mid third of the sinus (87%), in the posterior third (10%) or in the anterior third (3%); the right coronary orifice may be located in the mid third of the sinus (40%), in the posterior third (59%) or in the anterior third (1%) (Banchi, 1904; Hackensellner, 1954).

In the frontal plane, the position of the coronary orifices is described in terms of their relation to the sinotubular junction. "Low take-off" coronary orifices are situated in the lowest part of the aortic sinus. This position may be observed in normal hearts, but it is more frequent in hearts in which one of the coronary arteries originates in the pulmonary artery (Vlodaver et al., 1975). "High take-off" coronary orifices are situated some 10 mm above the line of the sinotubular junction (Vlodaver et al., 1975); they usually correspond to the right coronary artery (Alexander and Griffith, 1956; Ogden, 1968). A high left coronary orifice is usually associated with a long left coronary artery and is therefore at a greater risk of injury during surgery, either due to a low clamping of the aorta or due to the incision of the aorta wall during valvular replacement (Neufeld and Schneeweiss, 1983). Most haemodynamists agree that high and low coronary orifices represent an added difficulty in coronary angiography (Paulin, 1983; Greeberg et al., 1989).

The most frequent position of the coronary orifices is at the level of the sinotubular junction or below it (56%), followed by a high left orifice and a low right orifice or at the level of the junction (30%). Less frequent is a high right orifice and a low left orifice or at the level of the junction (8%); the rarest combination is when both coronary orifices are high (6%) (Vlodaver et al., 1975).

Presence of multiple coronary orifices

Multiple orifices in the right aortic sinus: the most frequent variation is the presence of an accessory orifice for the conal artery (Figures 2 and 3), which is even given a name of its own:
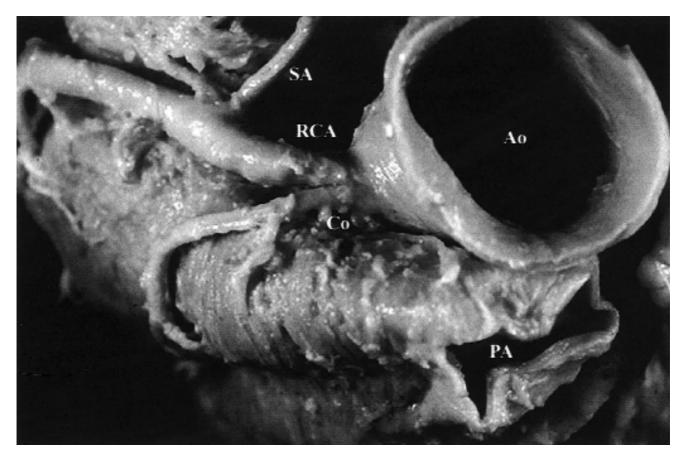

Figure 2. Independent origin of the right conal artery, situated anterior to the origin of right coronary artery. (Ao: aorta; Co: conal artery; PA: pulmonary artery; RCA: right coronary artery; SA: sinoatrial artery). x 2.5.

Figure 3. Interior view of the right aortic sinus, showing two orifices: one for the right coronary artery and the other for the conal artery . (Co: conal artery; RCA: right coronary artery). x 2.

the third coronary artery (Schlesinger et al., 1949). Its prevalence varies between 33% and 51% (Banchi, 1904; Crainicianu, 1922; Schlesinger et al., 1949). The orifice of the conal artery is usually in front of the coronary orifice or at the same level. The diameter varies between 0.5 and 1.5 mm. The conal artery irrigates the pulmonary infundibulum, and may anastomose with its homologous left artery; this anastomosis is known as the annulus of Vieussens. Less frequent independent orifices for the sinus node artery or for one of the right anterior ventricular branches have been described (McAlpine, 1975).

Multiple orifices in the left aortic sinus: the most frequent variation is the absence of a common trunk of the left coronary artery, which means that the anterior interventricular artery and the circumflex artery have different origins. The prevalence ranges between 0.5% and 1% (James, 1961; Zumbo et al, 1965). This variation may constitute both the existence of two separate, well defined orifices and a mixed orifice ("shotgun" orifice).

Multiple orifices in both aortic sinuses: There may be combinations of these multiple orifices giving rise to the presence of 4 or 5 independent orifices (Crainicianu, 1922; Baroldi and Scomazzoni, 1965; Waller, 1983). In the left aortic sinus there are reports of the coexistence of an independent origin for the interventricular anterior and circumflex arteries or the duplication of either, together with the presence of one or two independent orifices for the conal arteries in the right aortic sinus (Waller, 1983). An additional orifice has also been observed in the right aortic sinus for a duplicated anterior inter-

ventricular artery, together with a normal left aortic sinus (Das et al., 1986).

VARIATIONS IN LENGTH AND DISTRIBUTION OF THE CORONARY ANTERIES

Left coronary artery

Common trunk of the left coronary artery: The common trunk is described as long when it is above 15 mm (Figure 4). A long common trunk is present in between 11.5% and 18% (Helwing, 1967; McAlpine, 1975; Petit and Reig, 1993). The common trunk is considered short when it measures equal to or less than 5 mm (Vlodaver et al., 1976) (Figure 5). Its frequency varies between 7% and 12% (McAlpine, 1975; Leguerrier et al., 1976; Petit and Reig, 1993). The short common trunk many be clinically relevant, especially when a perioperative coronary perfusion or a coronariography is performed, because an incomplete image of the area of distribution of the left coronary artery may be seen on introducing the catheter into only one of the terminal branches, and the other does not then show opacification (Vlodaver, 1976). It has also been

Figure 4. Long common trunk of the left coronary artery (23 mm). The origin of its two terminal branches, the anterior interventricular artery and the circumflex artery. (CX: circumflex artery; D: diagonal artery; IVA: anterior interventricular artery; L: lateral or antero-lateral artery; LCA: left coronary artery; PA: pulmonary artery).
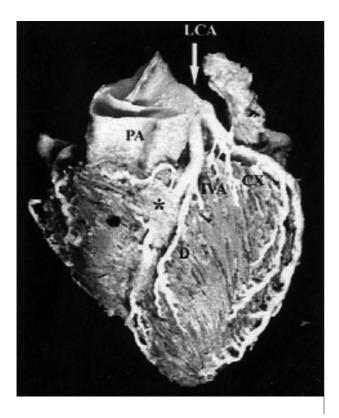
Figure 5. Short common trunk of the left coronary artery (2 mm). The mid third of the anterior interventricular artery is covered by a bridge of myocardial fibers (*). (CX: circumflex artery; D: diagonal artery; IVA: anterior interventricular artery; LCA: left coronary artery; PA: pulmonary artery).
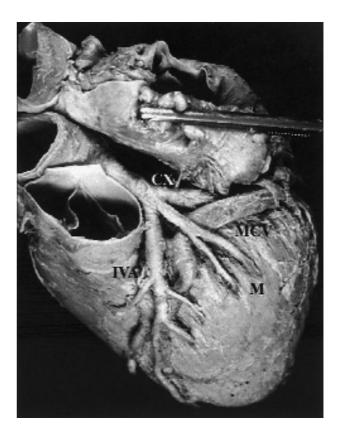

Figure 6. Division of the left coronary artery into tres branches: anterior interventricular, median and circumflex. The median artery clearly occupies the bisectrix of the angle formed by the two other terminal branches, crossing the surface of the great cardiac vein. (CX: circumflex artery; IVA: anterior interventricular artery; M: Median artery; MCV: great cardiac vein).

observed that a short common trunk presents the same potential risk as the absence of the common trunk altogether (McAlpine, 1975). Other authors report the existence of a short common trunk as a risk factor for the development of coronary arteriosclerosis (Gazetopoulos et al., 1976a,b) or as a cause of blockage in the left branch of the bundle of His (Lewis et al., 1970).

The division of the common trunk into anterior interventricular artery, circumflex, and median or intermediate artery (Figure 6) is a variation found in between 25% and 40% of cases (Banchi, 1904; Baroldi and Scomazzoni, 1965; Leguerrier et al., 1976; Hadziselimovic, 1982, Baptista et al, 1991; Petit and Reig, 1993). A median artery is one which: 1) originates in the vertex of the angle formed by the main terminal arteries of the left coronary artery, or in the first millimeters, 2) possesses a substantial caliber and 3) has an area of distribution extending half way down the free wall of the left ventricle (James, 1961; Angelini et al, 1999). The median artery follows an oblique route via the sternocostal surface of the left ventricle, frequently reaching the midpoint between the cardiac base and the *apex cordis*. On occasion, it may reach the *apex cordis* itself, or head towards the apical 2/3 of the *margo obtusus*, until reaching the

diaphragmatic surface of the left ventricle. The caliber of the median artery may on occasion be similar to that of the anterior interventricular artery or greater than that of the circumflex artery. For this reason, Levin (1983) states that, unlike certain hemodynamists, we should not focus our angiographic examination solely on the search for lesions in the interventricular anterior and circumflex arteries since the involvement of the median artery may, depending on its distribution, be as dangerous as the involvement of the two arteries (Roberts et al. 1986). The median artery may be the origin of arteries in the sterno-costal surface of the left ventricle, one or more anterior septal artery, and arteries of the anterior papillary muscle of the left ventricle. Therefore, in certain cases and depending on its distribution, the median artery may play an important role as a collateral vessel, in the derivation of the coronary circulation.

Anterior interventricular artery: Situated in the *incisura apicis cordis*, some 1-3 cm to the right of the *apex cordis* (Bosco 1935), this artery may end before reaching the apex, in the apex itself, or more frequently pass around the apex and reach the interventricular posterior groove

The bifurcation of the anterior interventricular artery is found at the limit between anomalies and anatomic variations, since it is reported in 1% of cases. This variation-anomaly consists of an early bifurcation of the anterior interventricular artery, giving rise to two arteries which are defined as long or short anterior interventricular arteries depending on their length (Spindola-Franco et al., 1983). The bifurcation of the anterior interventricular artery should be distinguished from cases of voluminous diagonal arteries, which course in parallel to the anterior interventricular artery (Figure 7), wrongly described as a bifurcation by some authors (James 1961, Paulin 1964, Baroldi and Scomazzoni 1965), especially in cases in which there are septal arteries that originate in the diagonal artery. From the anatomical point of view and from the angiographical point of view as well, a diagonal artery parallel to the anterior interventricular artery can be distinguished from a bifurcation of this artery, because the diagonal artery never reaches the interventricular anterior groove (Spindola-Franco et al. 1983). The importance of this variation is above all surgical, since, if it is ignored, during coronary bypass there is a risk that only a part of the vessel affected will be revascularized:that is, one of the anterior interventricular arteries.

Circumflex artery: of the three main coronary arteries, the circumflex artery is the one that presents the greatest variability in terms of length and distribution. Table I shows the percentages of this artery's termination points in the series published. Two points of reference are generally used to situate the termination of the circumflex artery: the *margo obtusus*, and the *crux cordis* (Figures 8 and 9). In most of the series published, the termination of the circumflex artery is found between the *margo obtusus* and the *crux cordis*, though in between 20 -30% the circumflex artery does not reach the diaphragmatic surface of the heart, and terminates as an artery of the *margo obtusus*. The percentage of cases in which the circumflex artery reaches the *crux cordis*, or goes beyond it, is very low.

Right coronary artery

The length of the right coronary artery is highly variable. As reference points for its termi-

Figure 7. The inverted S shape of the anterior interventricular artery. A voluminous diagonal artery can also be seen, in parallel to the anterior interventricular artery. (D: diagonal artery; IVA: anterior interventricular artery; PA: pulmonary artery).

(Figure 9). The length at this level is variable; in some cases it may be longer than half of the interventricular posterior groove. The portion of the artery that is lodged in the interventricular posterior groove is known as the "posterior recurrent interventricular artery" (Mouchet 1933). There appears to be relation between the length of this artery and that of the interventricular posterior artery (the branch of the right coronary artery or of the circumflex artery); indeed, on occasion the recurrent artery may entirely substitute the interventricular posterior artery (Paulin 1964, Baroldi and Scomazzoni 1965). In this case the circulation of the interventricular wall depends entirely on the anterior interventricular artery. However, these two arteries may be anastomosed (Cohen, 1985).

Table 1.- Percentages of the different types of termination of the circumflex artery.

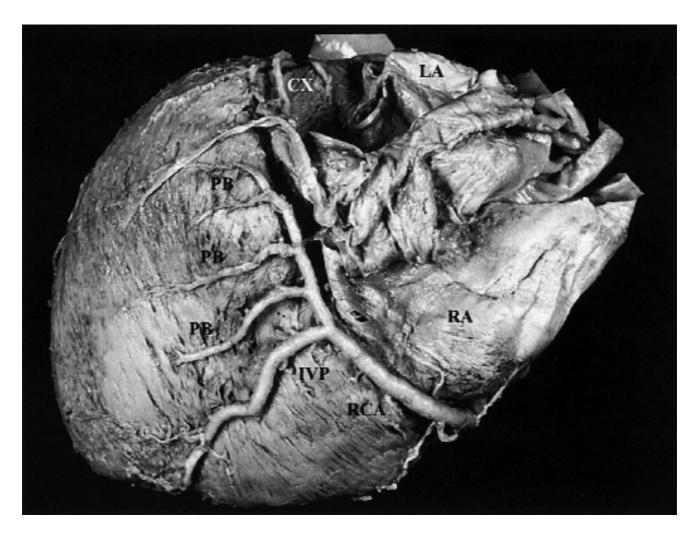|	Cases	margo obtusus	margo obtusus/ crux cordis	crux cordis	crux cordis/ margo acutus
Banchi (1904)	100	19		70	11
Crainicianu (1922)	200	15	75	10	
Mouchet (1933)	100	10	82	8	
Bosco (1935)	135	25	45	12	8
James (1961)	106	22	60	9	9
Baroldi y Scomazonni (1965)	522	25	63	5	7

Figure 8. View of the diaphragmatic surface of the heart; the right coronary artery passes the *crux cordis*, irrigating the right ventricle (right dominance). The circumflex artery is short, terminating a little after the *margo obtusus*. (CX: circumflex artery; IVP: posterior interventricular artery; LA: left atrium; PB: posterobasal artery; RA: right atrium; RCA: right coronary artery).

nation James (1961), and Baroldi and Scomazzoni (1965) used the anatomical borders of the heart and the *crux cordis*, thus allowing comparison with the circumflex artery (Figures 8 and 9). In more than 70% of cases, the right coronary artery goes beyond the *crux cordis* (Table II).

The points of termination of the circumflex and right coronary arteries in relation to the *crux cordis* have been used to establish coronary dominance. Schlesinger (1940) reported right dominance in 48% of hearts, left dominance in 18% and a balance in 34%. Nonetheless, other authors have reported much higher percentages for right dominance: between 60% and 80% (Pitt 1963, Baroldi and Scomazzoni 1965, DiDio and Wakefield 1975, Crawford 1977).

Table 2.- Percentages of the different types of termination of the rigth coronary artery.

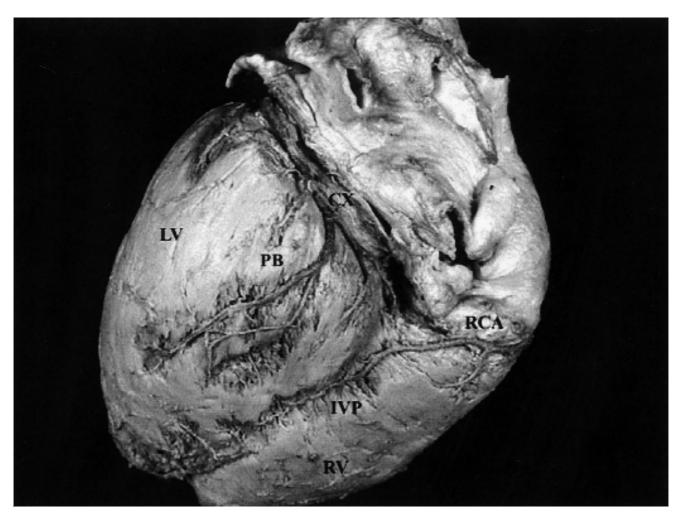|	Cases	margo acutus	margo acutus/ crux cordis	crux cordis	crux cordis/ margo obtusus	margo obtusus
Banchi (1904)	100		12	8	75	5
Gross (1921)	100	4		10	66	20
Crainicianu (1922)	200		10	10	70	20
Mouchet (1933)	100		8	12	80	
Bosco (1935)	135		8	22	70	
James (1961)	106	2	7	9	64	18
Baroldi y Scomazonni (1965)	522		10	9	64	17

Figure 9. View of the diaphragmatic surface of the heart in a situation of cardiac balance, in which the right coronary and the circumflex arteries irrigate the diaphragmatic surface of its corresponding ventricle. The anterior interventricular artery goes around the apex cordis and ascends a few millimetres via the posterior interventricular groove, constituting the posterior recurrent interventricular artery of Mouchet. (CX: circumflex artery; IVP: posterior interventricular artery; LV: left ventricle; PB: posterobasal artery; RV: right ventricle; RCA: right coronary artery).

VARIATIONS IN THE ROUTE OF THE CORONARY ANTERIES

The main coronary arteries, equivalent to the arteries of conduction in the classification by Estes et al.. (1966), habitually follow an epicardial route. On occasion the epicardial arteries penetrate the into the myocardium for part of their route and finally occupy their habitual epicardial position (Figures 5 and 10). This phenomenon, first described by Reyman (1737), has received a number of names: **myocardial bridge,** the portion of the myocardium that covers the artery (Tandler 1912; Polacek 1961; Angelini et al, 1983), and the **coronary mural** (Geiringer 1951) or **submerged artery** (Hadziselimovic 1982) the portion of the artery that is covered by the myocardium. Table III shows the percentages of myocardial bridge detected using a range of techniques. Dissection is the technique that offers the highest frequency, surpassing 50% of cases in some series. The most frequent location is above the anterior interventricular artery, especially in its middle third, followed by the left marginal artery. Noble et al (1976) described the **milking effect** of the myocardial bridges on the coronary arteries. Sometimes, the contraction of myocardial bridges may reduce the caliber of the artery by more than 75%, and so in situations requiring a substantial oxygen supply to the myocardial cells, the electrocardiogram may present anomalies compatible with ischemia and lactate production. This is the basis for the hypothesis that the myocardial bridges may be the cause of myocardial ischemia (Noble et al, 1976; Voelker et al, 1988). The morphometric characteristics of the nuclei of the fibers of the myocardial bridges are different from those of the adjacent myocardial cells, leading Reig et al (1990) to suggest that the fibers of the myocardial bridges were less functional than those in the rest of the myocardium. The myocardial bridges are a risk factor for certain surgical interventions, in particular aorto-coronary bypasses that affect the anterior interventricular artery. This is because the submerged portion

Table 3.- Characteristics of myocardial bridges in published series.

AUTHOR	YEAR	METHOD	CASES	PERCENTAGE	ARTERY
GEIRINGER	1951	Dissection	100	23.0%	Anterior Interventricular
EDWARDS et al	1956	Histotopografic sections	276	5.4%	All coronary arteries
POLACECK	1961	Dissection	70	85.7%	All coronary arteries
NOBLE et al	1976	Angiography	5.250	0.5%	Anterior Interventricular
PENTHER et al	1977	Dissection	187	17.6%	Anterior Interventricular
ISHIMORI et al	1980	Angiography	313	1.6%	Anterior Interventricular
STOLTE et al	1977	Dissection + Histotopografic sections	711	22.9%	Anterior Interventricular
HADZISELIMOVIC	1982	Dissection	100	52%	All coronary arteries
KRAMER et al	1982	Angiography	658	12%	Anterior Interventricular
IRVIN	1982	Angiography	465	7.5%	Anterior Interventricular
ANGELINI et al	1983	Angiography	1.100	5.5%	Anterior Interventricular
BINIA et al	1988	Angiography	600	4%	All coronary arteries
PETIT & REIG	1993	Dissection	100	58%	All coronary arteries

of the artery is only a few millimeters from the right ventricle, and there is a risk of perforation during the surgical maneuvers to identify the artery. In addition, in cases that involve the handling of the right infundibulum –for instance, to repair congenital tronco-conal car-
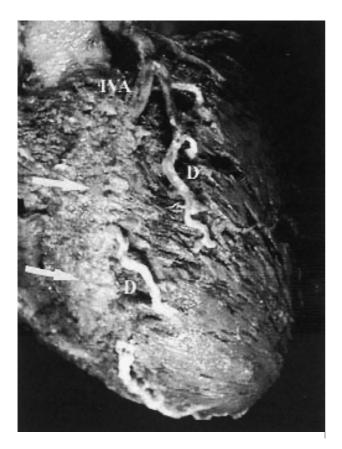

Figure 10. A great myocardial bridge (arrows) covering much of the anterior interventricular artery. One of the diagonal arteries crosses the fibers of the bridge, to become superficial. (D: diagonal artery; IVA: anterior interventricular artery). x 1.5.

diopathies or to replace cardiac valves– a conal artery, or the initial portion of an acute marginal artery, partially covered by a myocardial bridge, may be sectioned. Presumably, too, only a part of the myocardial bridges produces a systolic contraction that can be detected by coronary angiography, and so on many occasions the myocardial bridge may only be found during surgery, which may complicate the course of the intervention.

On occasion, the coronary arteries present intracavitary trajectories. The right coronary artery has been reported to pass through the right atrium, and the anterior interventricular artery inside the left ventricular infundibulum (McAlpine, 1975). In both cases, the artery's position inside the cavity may make manipulation difficult during heart surgery.

VARIATIONS IN THE ORIGIN OF SIGNIFICATIVE COLLATERAL ARTERIES

Sinusal or sinoatrial artery

The sinus node artery arises from the right coronary artery (in 54% if cases), from the circumflex artery in 42%, from both arteries in 2%, and in 2% the origin is undetermined (James, 1961). In the case of double blood supply, one of the arteries always has a greater caliber (Romhilt et al., 1968). Some cases have been described in which the sinus artery does not arise in the right aortic sinus (Kennel and Titus, 1972) or originates in a bronchial artery or directly from the internal thoracic artery (McAlpine, 1975).

When the sinus artery arises in the right coronary artery, it does so directly, via the anterior, mid or posterior atrial group. The largest

Figure 11. Sinus node artery originating in the initial portion of the right coronary artery. This artery divides to form a pericaval arterial ring. (RA: right atrium; RCA: right coronary artery; SA: sinoatrial artery; SVC: superior vena cava). x 1.5.

artery in the anterior atrial group reaches the node in 45% of cases in a counter-clockwise direction (passing behind the atrio-caval junction and entering via the inferior pole of the sinus node), in 35% of cases in a clockwise direction (passing in front of the atrio-caval junction and entering via the superior pole of the sinus node) and in 20% of cases forming a pericaval ring (entering the node by both poles) (Figure 11). In the mid-atrial group, the atrial artery of the right edge ascends by the auricular wall until the intercaval region, and supplies the sinus node in between 5% and 7% of cases (Kennel and Titus, 1972; Nerantzis et al., 1983). In cases in which the node is supplied by one of the arteries in the posterior atrial group, this artery will have an anterior trajectory, occupying the roof of the atrium (Vieweg et al., 1975; Nerantzis et al., 1983).

When the sinus artery originates in the circumflex artery it does so via the left anterior atrial artery (the most frequent), the atrial circumflex artery, the artery of the left atrial margin or the left posterior atrial artery (James and Burch, 1958; Vieweg et al., 1975; Nerantzis and Augoustakis, 1980; Nerantzis et al., 1983). The

anterior left atrial artery originates in the first millimeters of the circumflex artery or in the common trunk of the left coronary artery. It follows the roof of the left atrium and the interatrial wall and penetrates the sinus node in a conter-clockwise direction. The atrial circumflex artery may form part of the anterior or mid-atrial group. The artery of the left atrial margin arises some 10-15 mm from the origin of the circumflex artery, reaches the base of the left appendage crossing its lateral surface obliquely, reaching the superior vena cava and supplying the interatrial wall and the sinus node. The posterior left atrial artery originates in the final portion of the circumflex artery may supply the sinus artery, also known as the "S-shaped atrial artery" (Nerantzis and Augoustakis, 1980; Habbab et al, 1989) because of the two curves in its trajectory, one near its origin and the other near the lateral or posterolateral surface of the left atrium (Figure 12).

Atrioventricular node artery

The atrioventricular node artery may originate in the right coronary artery (86% of cases) the circumflex artery (12%) or in both arteries in 2% (Bosco, 1935; James, 1961; Baroldi and Scomazzoni, 1965; Petit and Reig, 1993). Habitually, the atrioventricular node is irrigated by the artery that reaches the *crux cordis* and supplies the posterior interventricular artery, although as noted by McAlpine (1975) coronary dominance does not automatically reflect the origin of the node artery; in that series, in 17% of cases in which the posterior interventricular artery usually originates on the right, the node artery originated on the left in balanced coronary distributions.

Posterior interventricular artery

The posterior interventricular artery may originate in the right coronary artery, the circumflex artery or in both. Its origin is at the level of the *crux cordis*, or a few millimeters either in front or behind it (Figures 8 and 9). It may be a collateral or a terminal branch. The origin of the posterior interventricular artery is one of the parameters on which Schlesinger's (1940) system of arterial dominances is based. In the case of right-sided dominance, the posterior interventricular artery originates in the right coronary artery in 50-60% of cases; if dominance is left-sided, the posterior interventricular artery originates in the circumflex artery –in 10-15% of cases; and in the case of balanced situation, the origin is also the right coronary artery (30-40%), though in some cases there are two interventricular posterior arteries, one arising in the right coronary artery, and the other in the circumflex artery.
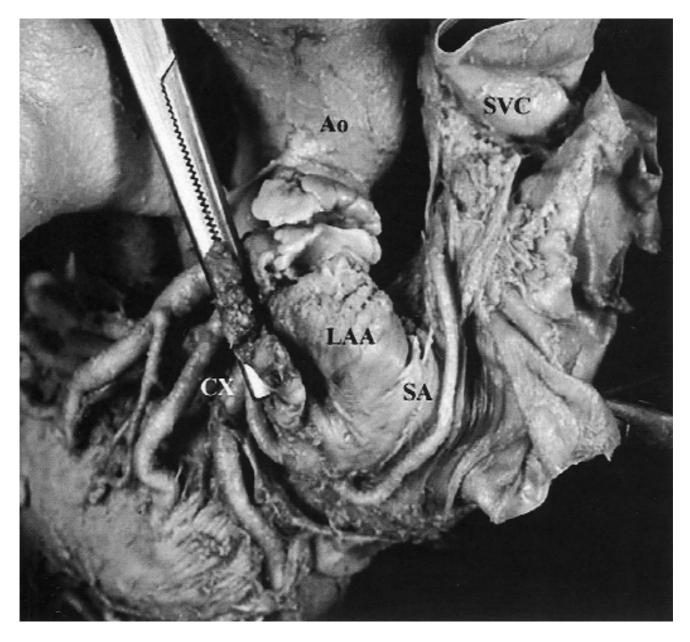
Figure 12. Sinus node artery originating in the posterior portion of the circumflex artery. The artery presents the characteristic S-shape (Ao: aorta; CX: circumflex artery; LAA: left atrial appendage; SA: sinoatrial artery; SVC: superior vena cava). x 3.5.

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