# Great Cardiac Vein Draining Directly Into The Right Atrium - A Case Report

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**Abstract:** Compared to the coronary arterial system, less attention has been paid to the coronary venous system. In the current scenario, there are therapeutic options for arrhythmias and for heart failure that the use of coronary venous system to access target areas. The venous system is also a useful conduit for delivery of percutaneous transcatheter treatment. Variations in the veins in terms of valves , diameter, angulation, extent of muscular sleeves, proximity to other cardiac structures, and cross-over spatial relationship with branches of coronary arteries have implications for practitioners seeking to make use of the system. Also retrograde cardioplegia is achieved through the cardiac veins during cardiac surgeries. The present case report deals with the incidental finding of the great cardiac vein draining directly into the right atrium instead of the coronary sinus, during routine dissection of the heart of an adult male cadaver. The coronary sinus was normal and it opened into the right atrium separately as usual. No other variation was found in relation to the heart. The clinical implications, embryological basis and comparative anatomy of the great cardiac vein are discussed.

**Key words:** Great Cardiac Vein, Direct Opening, Right Atrium, Normal Coronary sinus

## Introduction:

Variation is the law of nature. Every human is unique anatomically to such an extent that even identical twins are not exactly alike. Like in all others, each of the twins has own unique fingerprints. Even a lay person can make out that there are wide differences between persons. Some of the variations are of considerable clinical significance, e.g. differences in the anastomotic arrangement between the arteries at the base of the brain, while others may not have much significance, e.g. an extra belly to a particular muscle or the marked difference in the arrangement of the superficial veins even on the two sides of the body (Romanes G J, 1986). Many variations pertaining to the coronary arterial system have been described but less attention has been paid to the coronary venous system. In the current scenario, there are therapeutic options for arrhythmias and for heart failure that use the coronary venous system to access target areas. The venous system is also a useful conduit for delivery of percutaneous transcatheter treatment. Variability in terms of valves, diameter, angulation, extent of muscular sleeves, proximity to other cardiac structures, and cross-over spatial relationship with branches of coronary arteries have implications for practitioners seeking to make use of the system (Ho S Y et al, 2004). Also retrograde cardioplegia is achieved through the cardiac veins during cardiac surgeries. Hence any variation in the veins of the heart is significant.

## Observations:

During routine dissection of the heart of an adult male cadaver, it was found that the great cardiac vein drained directly into the right atrium. It began at the cardiac apex to the right of the left anterior descending artery, ascended in the anterior interventricular sulcus, and crossed the left anterior descending artery superficially in the middle of the sulcus to reach its left side. Further it ascended and crossed the left circumflex artery superficially and reached the anterior wall of the transverse sinus of the pericardium behind the great arteries. Then it opened into the postero-superior aspect of the right atrium. The opening was not guarded by any valve (Fig. 1, Fig. 2 and Fig. 3).

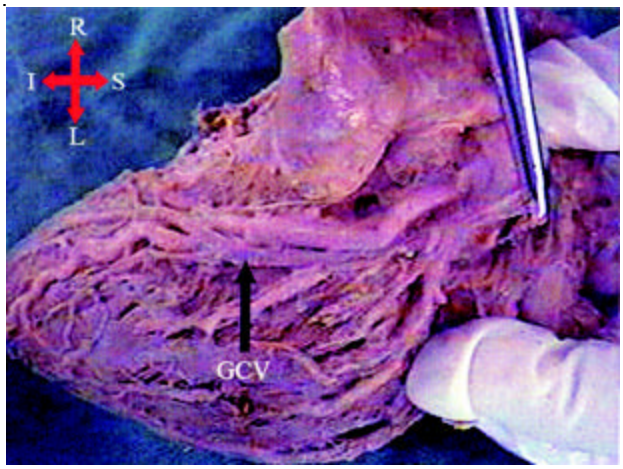


**Fig.1** Great cardian vein (black arrow) in the anterior interventricular sulcus. GCV-great cardian vein, S-superior, I-inferior, R-right, L-left.

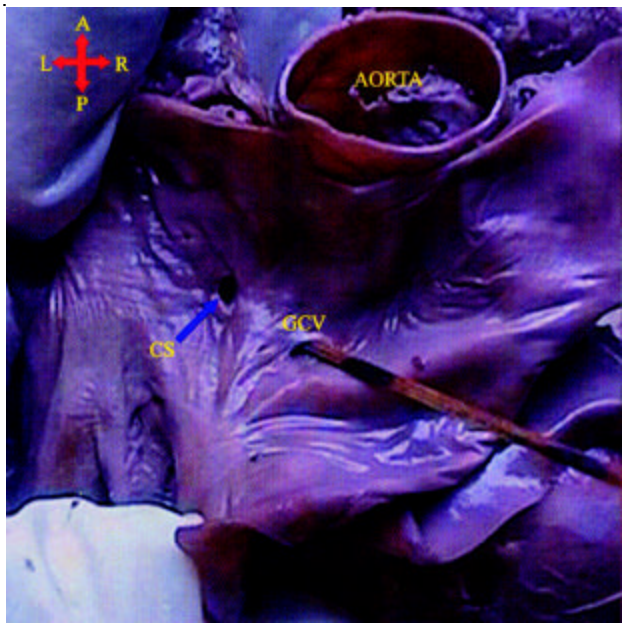


**Fig.2** Interior of the right atrium showing the opening of the coronary sinus (blue arrow) and the opening of the great cardiac in (probe). CS-coronary sinus, GCV-great cardiac vein, A-anterior, P-posterior, R-right, L-Left.

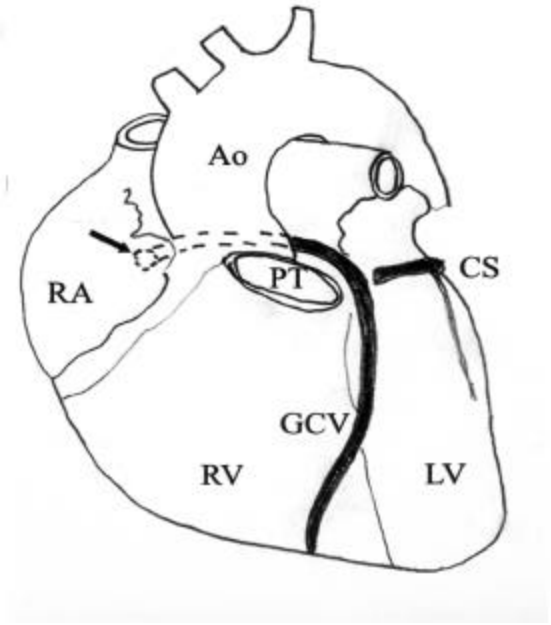


**Fig.3** Line diagram showing the course of the great cardiac vein in the current case. GCV-great cardiac vein, RA-right atrium, RV-right ventricle, LV-left ventricle, CS-coronary sinus, PT-pulmonary trunk, Ao-Aorta. Black arrow represents the opening of the GCV in the RA.

The coronary sinus was normal. No other variation was found in the heart. Great cardiac vein received its normal tributaries i.e. from the left atrium and both the ventricles.

**Discussion :**

Veins of the heart can be grouped as:

1) The coronary sinus and its five normal tributaries namely, the great cardiac vein the middle cardiac vein, the small cardiac vein, the posterior cardiac vein of left ventricle and the oblique vein of left atrium (of Marshall). It returns the blood to the atrium from the whole heart (including its septa) except the anterior region of the right ventricle and small, variable parts of both atria and the left ventricle.
2) The anterior cardiac veins drain an anterior region of the right ventricle and a region around the right cardiac border when the right marginal vein joins this group, ending principally in the right atrium.
3) Venae cordis minimae (Thebesian veins) open into the right atrium and ventricle and to a lesser extent, the left atrium and sometimes the left ventricle.

The coronary sinus lies in the posterior part of the coronary sulcus (atrioventricular groove) and opens in the right atrium between the opening of the inferior vena cava and the right atrioventricular orifice, its opening being guarded by a semilunar valve (Thebesian valve). The great cardiac vein begins at the cardiac apex, ascends in the anterior interventricular sulcus to the coronary sulcus and follows this to the left and round, posterior to the heart to enter the left end of the coronary sinus i.e. at its origin (Fig.4). Here its orifice is guarded

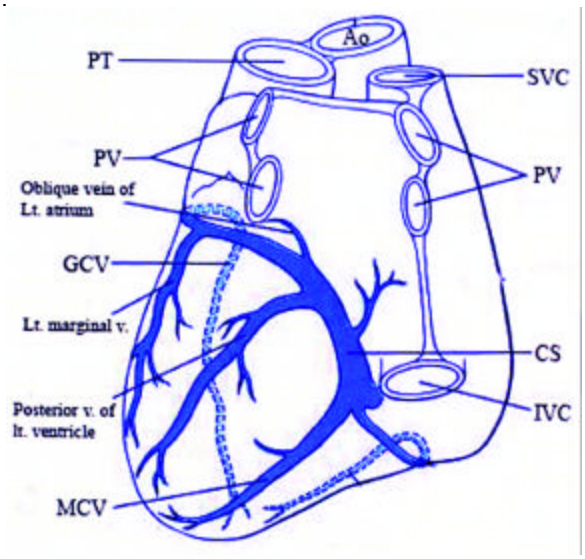


**Fig.4** Line diagram showing the veins of the heart. GCV-great cardiac vein, MCV-middle cardiac vein, CS-coronary sinus, PV-pulmonary veins, SVC-superior vena cava, IVC-inferior vena cava, PT-pulmonary trunk, Ao-aorta.

by a valve. It receives tributaries from the left atrium and both the ventricles, including the larger left marginal vein ascending the left aspect (obtuse border) of the heart (Williams et al, 1995).

Attempts to categorize variations in cardiac venous circulation into 'types' have not produced any accepted pattern. Major variations concern the general directions of drainage. The coronary sinus may receive all cardiac veins (except the venae cordis minimae) including the anterior cardiac veins (33%) which may be reduced by diversion of some into the small cardiac vein and then to coronary sinus (28%); the remainder (39%) represent the normal pattern as described above. Distinguished two major variants: a majority (70%) in which the small cardiac vein is independent, small or absent and a less frequent pattern (30%) in which this vein, though variable in size, connects with both coronary and the anterior cardiac 'systems' (Williams et al, 1995).

Variations in the course of the great cardiac vein have been little studied until recently. Commonly, the great cardiac vein varies with respect to presence, location, and the superficial or deep relationship of single crossings of left anterior descending and left circumflex arteries. A case of intertwining of the great cardiac vein with the left circumflex artery was found where the origin and the termination of the great cardiac vein were normal (Bales, 2004). This may have important basic science implications for understanding mechanisms of vasculo-angiogenesis, and clinical implications for catheter-based procedures and surgeries in the region of the coronary sulcus.

Valve of the great cardiac vein has been studied with respect to its presence or absence and its location. The terminal valve of the great cardiac vein was found in 92% of the examined hearts. To define the location of the valve of the great cardiac vein, the ostium of the oblique vein of the left atrium was treated as the reference point. In 3% of cases the presence of the valve was observed independently of the opening of the left atrial oblique vein. The valve of the great cardiac vein was placed proximally from the opening of the left atrial oblique vein. The valve of the great cardiac vein placed distally in relation to the beginning of the coronary sinus was never observed. The three types of the great cardiac vein valves were found: 1. single, semilunar cusp; 2. endothelial fold; 3. double pouches (Cendrowska-Pinkosz M et al, 2004).

Variations pertaining to the absence of the coronary sinus have been reported (Bergman et al, 1988 and Kawashima et al, 2003). In such cases the great cardiac vein drains into the superior vena cava or the left brachiocephalic vein. Several veins, including the middle cardiac converge to empty into the right atrium. Also absence of an ostium for the coronary sinus in the right atrium has been described (Bergman et al, 1988). Here blood carried in the cardiac veins may reach the right atrium by passing successively into the left superior vena cava, left brachiocephalic vein and the right superior vena cava.

In a study of 350 hearts a case of a large conus vein was reported. This was the great cardiac vein joining with the anterior cardiac vein. Its continuation passed the arterial conus and joined directly the right atrium (von Ludinghausen M, 1987). In our case report, the great cardiac vein did not join any other cardiac vein and opened directly into the right atrium and there were no other variations. Such a variation is not reported in literature. Clinicians need to be aware of this variation because it may be important in retrograde cardioplegia.

**Embryological basis**

The coronary sinus develops from the regressing left horn of sinus venosus and the medial persisting portion of the retrogressing left common cardinal vein (Fig. 5). The opening of the small left horn of sinus venosus represents the opening of the coronary sinus. The large right horn of sinus venosus forms the smooth part of the right atrium. The great cardiac vein develops from an endothelial sprout that extends from the cardiac apex, passes upwards in the anterior interventricular sulcus to join the left horn of sinus venosus (Moore, 2003). In the present case the endothelial sprout must have joined the right horn of sinus venosus instead of the left horn, resulting in the present anomaly.

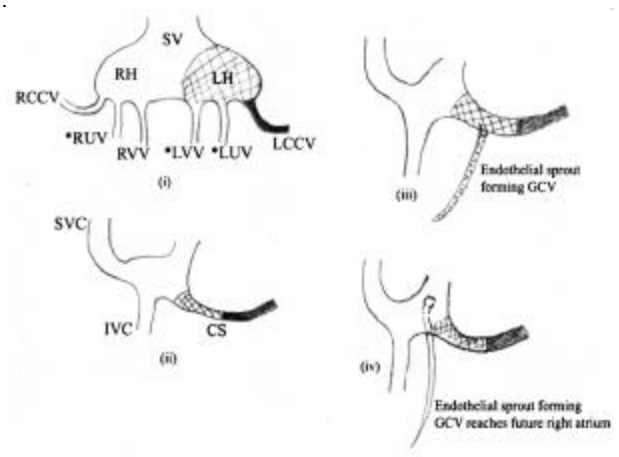


**Fig.5** Diagram showing development of the coronary sinus and the great cardiac vein (normal and the present case). SV-sinus venosus, RH-right horn, LH-left horn, RCCV-right common cardinal vein, LCCV-light common cardinal vein, RUV-right umbilical vein, LUV-left umbilical vein, RVV-right vitelline vein, LVV-left vitelline vein, SVC-superior vena cava, IVC-inferior vena cava.

**Diagnosis**

In a living person, the venous phase of coronary angiography may reveal this abnormality. 16-MDCT (16-slice Multidetector Computerized Tomography) angiography is also a valuable non-invasive imaging method that depicts cardiac venous anatomy and may be a valuable tool for guiding important transvenous therapeutic procedures like biventricular pacing (Abbara et al, 2005).

**Clinical Implications**

Retrograde cardioplegia is done in cardiac surgeries like valve replacement/repair, severe coronary lesions/ occlusion, left main disease, aortic incompetence, coronary reoperations, coronary grafts and paediatric cardiac surgeries (Arpesella G et al, 2000). It is achieved by introducing the cardioplegic drug (potassium chloride) through the coronary sinus after passing the catheter beyond the ostium of the coronary sinus (Fig. 6 and Fig. 7). The entire heart drained by the coronary sinus is perfused by the drug since no other valve is present. Remaining regions of the heart are perfused through the right coronary artery (Kirklin JW, et al, 1993).

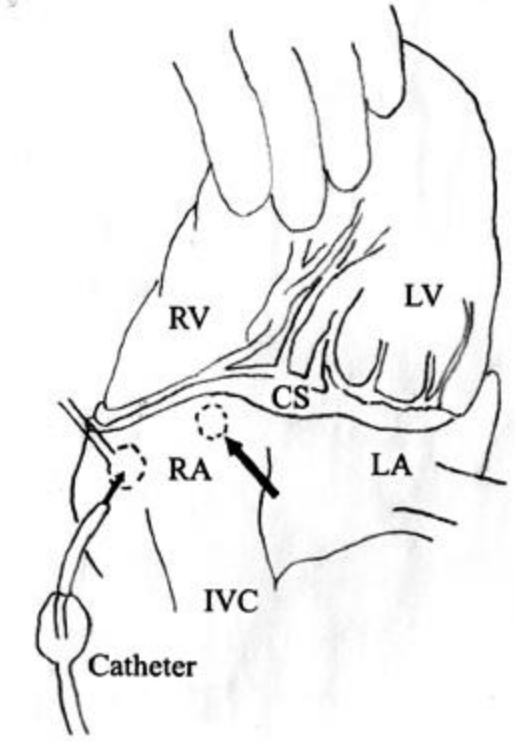


**Fig.6** Retrograde cardioplegia. Shows introduction of catheter through the right atrium (Modified and redrawn from Kirklin et al, 1993)

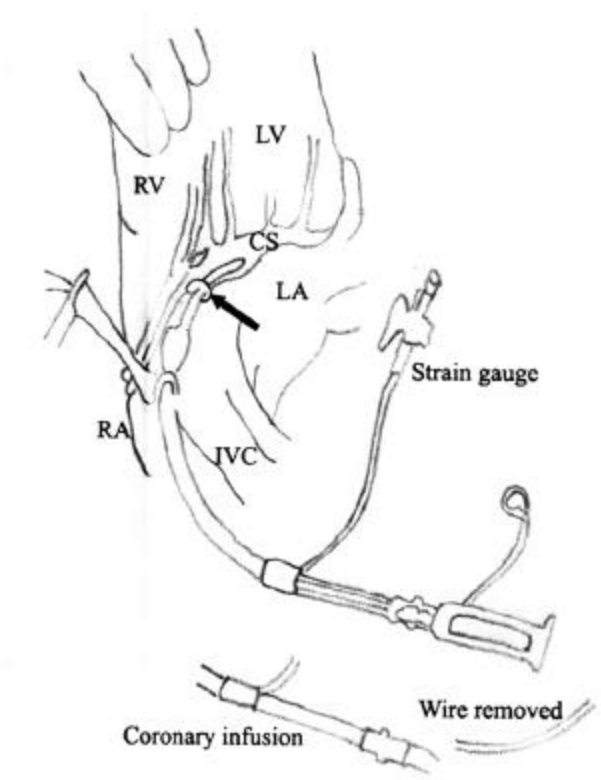


**Fig.7** Retrograde cardioplegia. Tip of the catheter is passed through the ostium of the coronary sinus (black arrow). (Modified and redrawn from Kirklin et al, 1993)

If the present variation is encountered, introducing the cardioplegic solution via the coronary sinus will not perfuse the entire left side of the heart. Postoperatively there will be some myocardial dysfunction due to non perfusion of the area drained by great cardiac vein. Left circumflex or left anterior descending artery can be used for perfusion but they may be blocked in an elderly individual. Hence in such a case retrograde cardioplegia can be done through the right atrium.

Since the opening of the great cardiac vein in the right atrium is very close to the interatrial septum it may be mistaken as an atrial septal defect during cardiac catheterization.

**Comparative Anatomy of Great cardiac vein**

In human, the great cardiac vein commences at the apex of heart while in buffalo, pig and goat it commences at the apical notch. Only in dog the great cardiac vein is formed by union of venae comitantes of anterior interventricular artery near the junction of anterior

interventricular sulcus with the coronary sulcus. In pig and goat it lies lateral to anterior interventricular artery while in buffalo it lies medial to anterior interventricular artery. In dog it is not related to anterior interventricular artery and in place of it venae comitantes are present. In human it lies superficial to anterior interventricular artery. Only in buffalo the great cardiac vein crosses from medial to lateral side lying ventral to anterior interventricular artery in the proximal 1/3 of anterior interventricular sulcus to reach on the lateral side of artery. In the coronary sulcus, the great cardiac vein lies superior to circumflex branch of left coronary artery in buffalo, pig and dog. In human, the great cardiac vein lies superficial to the circumflex branch of left coronary artery while in goat, the great cardiac vein lies deep to the circumflex branch of left coronary artery. In all mammals the great cardiac vein drains into the left extremity of the coronary sinus and drain the left atrium and both the ventricles (Kumar Keshaw, 2000). In Akkarman sheep and Angora goats also, the great cardiac vein drained into the coronary sinus (Besoluk K, 2001).

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