

Morphological analysis of the coronary sinus ostium by Multislice Computed Tomography

Analyse morphologique du sinus coronaire par coroscanner

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Résumé

Objectif : Déterminer les différentes variantes anatomiques du sinus coronaire (SC) à l'aide d'un coroscanner.

Méthode : Etude rétrospective incluant une série de 260 patients explorés pour suspicion d'une pathologie coronarienne. L'analyse anatomique de l'ostium du SC a été réalisée par un Scanner 16 coupes avec acquisition hélicoïdale 16 x 0,625mm, un temps de rotation du tube de 400mS. La détection automatique de l'arrivée de produit de contraste dans l'aorte ascendante a été utilisée pour le début de l'acquisition. Si la fréquence cardiaque dépasse 65 battements/min, une dose de bêta-bloquants a été administrée. Pour une meilleure étude CS, les images axiales ont été choisies au cours de la phase de 75% de l'intervalle RR. L'analyse morphologique réalisée par une reconstruction multiplanaire concerne la qualité d'opacification de la SC. L'évaluation de la qualité d'opacification de l'ostium coronaire a été réalisée à l'aide d'une échelle visuelle qualitative. Le diamètre de l'ostium antéro-postérieur du SC, l'angulation de l'ostium SC et la taille de la valve de Thebesius ont été mesurés manuellement au moyen d'une reconstruction multiplanaire.

Résultats: L'opacification du SC était de bonne qualité dans tous les cas et excellente dans 45%. Le diamètre moyen de l'ostium du SC était de 13,2 mm, le diamètre crano-caudal de l'ostium était toujours supérieur au diamètre transversal expliquant la forme ovale de l'ostium. Une sténose ostiale et une dilatation ont été notés dans respectivement 5% et 4% des cas. Une angulation réduite <90% a été observée chez 6% de nos patients. Une valve de Thebesius a été observée dans 42% de nos patients. Elle était de grande taille dans 2% des cas. Une tortuosité du CS liée à une dilatation de l'oreillette droite a été observée chez 1% des patients et une fistule entre l'artère circonflexe et le SC a été constatée chez un patient.

Conclusion: Notre étude confirme la possibilité d'une analyse morphologique, et non-invasive du SC à l'aide d'un scanner 16 barrettes dans le cadre d'une exploration des artères coronaires.

Mots-clés

Tomodensitométrie,
veines coronaires, sinus
coronaire

Summary

Purpose : The purpose of our study was to determine the different anatomic variants of the coronary sinus (CS) ostium using a multislice computed tomography (MSCT).

Methods: This a retrospective study which included 260 patients explored for a suspected coronary artery disease from January 2013 to January 2014. The anatomic analysis of CS ostium was achieved via an electrogated 16 slice MSCT (general Electric Light Speed) with a 16 x 0.625-mm collimation, and a gantry rotation time of 400 ms, tube voltage : 120 kV and current : 300-440 Ma. The administration of 110 ml of the contrast agent was followed by a 45 ml bolus of saline serum. Automated detection of peak enhancement in the aortic root was used to time the scan (smartprep). Besides, if the heart rate exceeds 65 beats/min, a dose of beta-blockers was administrated unless contraindication. For a better CS study, axial images were chosen during the 75% phase of the RR interval. The morphological analysis realised by a multiplanar reconstruction concerned the opacification quality of the CS. The evaluation of the opacification quality of the coronary ostium was realised using a qualitative visual scale. The CS ostium antero-posterior diameter, the CS ostium angulation and the Thebesian size were measured manually using a multiplane reconstruction.

Results: The CS was identified for all our patients. The opacification was of a good quality in all the patients and of an excellent quality in 45% of them. The mean diameter of the CS ostium was 13.2mm, the crano-caudal diameter of the ostium was always superior to the transversal diameter explaining the oval shape of the ostium. Ostial stenosis and dilatation were noticed in 5% and 4% of our patients respectively. A reduced angulation < 90% was observed in 6% of our patients. A Thebesian valve was observed in 42% of our patients with different sizes. A large-sized Thebesian valve was observed in 2% of the patients. Tortuosity of CS related to a dilatation of the right atrium was observed in 1% of the patients and a fistula communication between the left circumflex and CS was noticed in one patient.

Conclusion: Our study confirms the possibility of a morphological and a non-invasive analysis of the CS using a 16 MSCT and during a coronary scan procedure.

Keywords

Computed tomography,
Coronary veins,
Coronary sinus

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INTRODUCTION

The coronary sinus (CS) represents for the major number of electrophysiological investigations the main intravenous access used in cardiology.

Knowledge of the anatomy of the coronary venous system (CVS) is an important part of successful left ventricular lead implantation, because in a small proportion of cases there are significant difficulties during catheterisation procedure due to the difficulty of CS cannulation [1, 2].

One may suppose that the study of the anatomy of the coronary venous system including its various components would lead to an easier implementation of the probe in the left ventricle and hence a shorter time spent on the total procedure.

The purpose of our study was to determine the different anatomic variants of the CS ostium using a multislice computed tomography (MSCT).

METHODS

This a retrospective study which included 280 patients explored for a suspected coronary artery disease from January 2013 to January 2014 were included in the study. Subjects were excluded if they presented any of the following: atrial fibrillation (permanent or persistent); frequent cardiac extrasystoles; renal insufficiency (serum creatinine ≥ 1.3 mg/dL) or a known allergy to non-ionic contrast agents. The anatomic analysis of CS ostium was achieved via an electro gated 16 slice MSCT (general Electric Lightspeed) with a 16 x 0.625-mm collimation, and a gantry rotation time of 400 ms, tube voltage : 120 kV and current : 300-440 Ma.

The administration of 110 ml of the contrast agent was followed by a 45 ml bolus of saline serum. Automated detection of peak enhancement in the aortic root was used to time the scan (smartprep). Besides, if the heart rate exceeds 65 beats/min, a dose of beta-blockers was administered unless contraindicated.

For a better CS study, axial images were chosen during the 75% phase of the RR interval (end-diastole) automatically. The morphological analysis realized by a multiplanar reconstruction concerned the opacification quality of the CS. The evaluation of the opacification quality of the coronary ostium was realized using a qualitative visual scale. The CS ostium antero-posterior diameter, the CS ostium angulation and the Thebesian size were measured manually using a multiplane reconstruction.

RESULTS

The patients age ranged from 19 to 79 years (mean age= 55.41), there were 165 men and 115 women.

The CS was identified for all our patients. The opacification was of a good quality in all the patients and of an excellent quality in 45% of them (Figure 1).

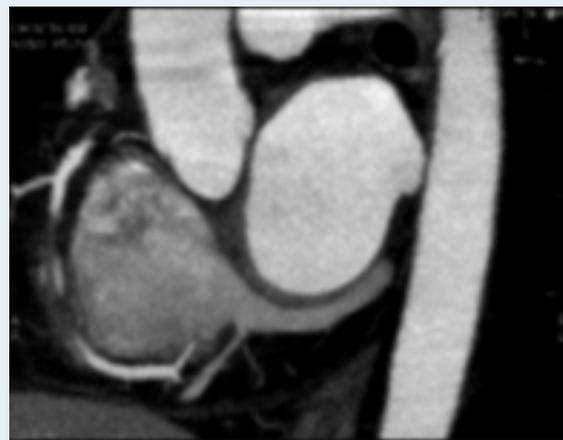


Figure 1: Multiplane reconstruction image showing an excellent opacification of coronary sinus

The mean diameter of the CS ostium was 12.8mm, the cranio-caudal diameter of the ostium was always superior to the transversal diameter explaining the oval shape of the ostium (Figure 2).

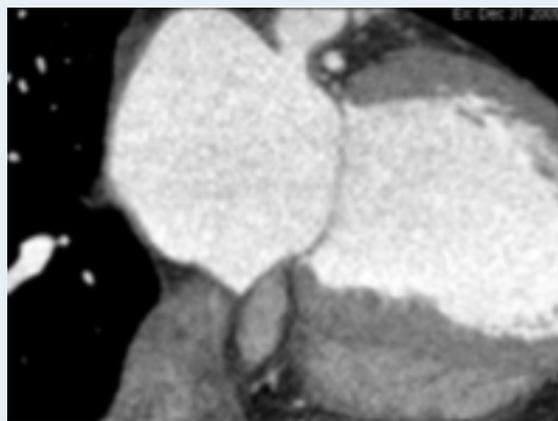


Figure 2: Oval shape of the ostium

Ostial stenosis (Figure 3) and dilatation were noticed in 5.35% and 4% of our patients respectively.

A reduced angulation $< 90^\circ$ (Figure 4) was observed in 5.5% of our patients. A Thebesian valve was observed in 43% of our patients with different sizes. A large-sized Thebesian valve was observed in 1.8% of the patients (Figure 5). Tortuosity of CS related to a dilatation of the right atrium was observed in 1% of the patients and a fistula communication between the left circumflex and CS was noticed in one patient (Figure 6).

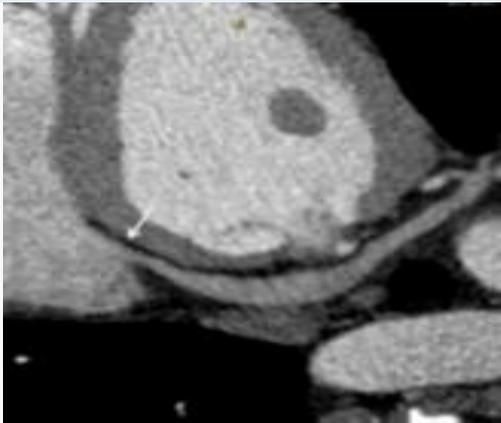


Figure 3: Curved multiplanar reconstruction of the coronary sinus shows ostial stenosis (arrow)

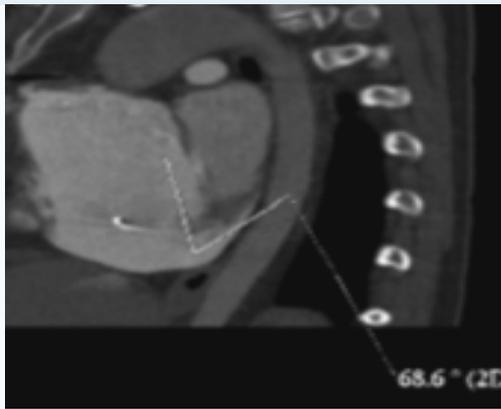


Figure 4: Multiplane reconstruction image showing a reduced angulation of the CS ostium



Figure 5: Curved multiplanar reconstruction of the coronary sinus shows a large-sized Thebesian valve (arrow)

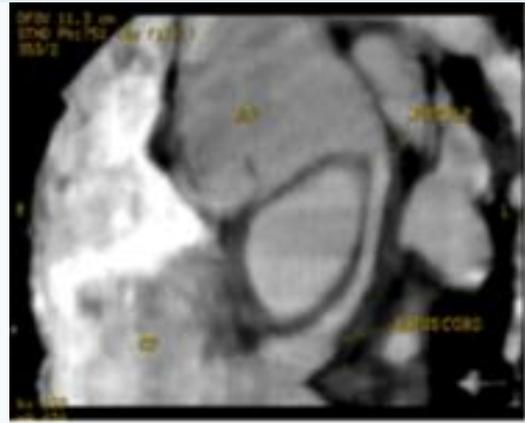


Figure 6: Curved multiplanar reconstruction of the coronary sinus shows a fistula communication between the left circumflex and CS

DISCUSSION

The main finding in the current study is the possibility of a morphological and a non-invasive analysis of the CS using a 16 MSCT and during a coronary scan procedure. The CS lies in the sulcus between the left atrium and ventricle and is a continuation of the great cardiac vein from the valve of the great cardiac vein to the ostium of the CS as it terminates in the right atrium. The CS, like the rest of the cardiac venous system, contains various valves. The length of the CS varies from 3 to 5.5 cm and is dependent on the site of the drainage of the posterolateral vein [3].

The most common valve is the Thebesian valve at the ostium of the CS. The Thebesian valve is a crescent shaped structure often found guarding the mouth of the CS as it opens to the right atrium.

The Thebesian valve is highly variable and occasionally may present an obstruction during cannulation of the CS. The CS ostium is 5-15 mm in diameter and is located on the posterior interatrial septum anterior to the Eustachian ridge and valve and posterior to the tricuspid annulus.

The ostium is often covered, to a variable extent, by the Thebesian valve. The valve usually covers the superior and posterior surfaces of the ostium, but may be covered completely with formation of fenestrations. In rare instances, the valve may cover the inferior circumference [3].

Coronary sinus cannulation is unsuccessful in 5-10% of the patients undergoing invasive cardiac procedures. Possible explanations include probing of the interatrial septum with the catheter at the incorrect location, and variations in operator skills and experience.

An unrecognized problem is one where the CS is cannulated but the catheter cannot be advanced through

the structure. Difficulties in advancing the catheter can be due to a very tortuous proximal CS, otherwise referred to as CS with a 'compound curve', or a CS with a very prominent valve of Vieussens [4].

A prominent Thebesian valve, may be an under-recognized problem interfering with CS cannulation. Furthermore, it has been reported that an unrecognized obstructive Thebesian valve may pose a significant challenge with regards to coronary venous lead placement for cardiac resynchronization therapy.

With the advent of imaging modalities, the anatomy of the CS and its tributaries may be depicted using multislice computed tomography (MSCT) [5].

Until recently, the cardiac venous system could only be evaluated invasively using retrograde venography, either by direct manual contrast injection or after occlusion of the coronary sinus.

In 2000, few studies reported on the use of non-invasive imaging with electron beam CT to depict the cardiac venous system. Recently, Mao et al. [6] analyzed the electron beam CT of 231 patients and demonstrated that this technique provides 3-dimensional (3-D) visualization of most components of the coronary venous system. In 2003, Tada et al. [7] reported the feasibility of MSCT to obtain high quality 3-D images of the cardiac venous system in one patient. Recently, preliminary studies were published on the value of 16-slice MSCT to evaluate the cardiac veins. Since then, 16-slice MSCT has gradually been replaced by 64-slice MSCT, offering a higher spatial resolution with a decreased acquisition time [8-12].

In fact, the feasibility of assessing the coronary venous anatomy is excellent, reaching almost 100% for the coronary sinus and the great cardiac vein.

Measurement of coronary sinus and great cardiac vein diameters can be performed in the majority of patients with low intra and inter-observer variability.

Using multiplanar reconstruction, the coronary veins are manually selected and elongated, and the diameters are automatically measured all along the veins. It has been shown that the diameter of the coronary sinus is larger in the supero-inferior direction than in the antero-posterior direction, indicating an oval shape. Lengths are also measured using this method. The tortuosity and curvature of the venous system can also be assessed using computed tomography, which helps to anticipate potential technical difficulties for implantation.

The ostium of the CS was defined as the site where the CS makes an angle with the right atrium in the crux cordis area.

Multiplanar reformatting was used to determine the size of the ostium in 2 directions [12].

In our study, The SC was identified for all our patients. The opacification was of a good quality in all the patients and of an excellent quality in 45% of them.

The mean diameter of the CS ostium was 12.8mm (the

diameter of the CS ostium was 12.6 +/- 3.6 mm in the study of Jongbloed et al [12].

The cranio-caudal diameter of the ostium was always superior to the transversal diameter explaining the oval shape of the ostium.

Ostial stenosis and dilatation were noticed in 5,35% and 4% of our patients respectively.

Furthermore, we have come across only one report detailing the use of electron beam CT in the evaluation of CS ostium and Thebesian valve.

Although it may be difficult to image thin and membranous Thebesian valves, thick valves may be visualized. A very recent report showed that the Thebesian valve was imaged in 50% of the 201 patients who underwent MSCT.

If a thick valve is seen to be present, the operator should recognize the potential challenge in cannulating the CS [4]. In our study, aThebesian valve was observed in 43% of our patients with different sizes. A large-sized Thebesian valve was observed in 1,8 % of the patients

CONCLUSION

Our study confirms the possibility of a morphological and a non-invasive analysis of the CS using a 16 MSCT and during a coronary scan procedure. This latter exam allowed in our study to identify patients showing morphological modifications of the CS ostium (19%). Our awareness of these variants before the procedure allows a decrease in the rate of failure of the CS cannulation and hence a shorter time spent on the total procedure.

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