CASE REPORT

An S-shaped sinoatrial nodal artery coronary artery fistula demonstrated by multidetector CT

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ABSTRACT. The presented case and discussion illustrate the use of CT coronary angiography to depict coronary artery fistulae. A 41-year-old man presented with an acute myocardial infarction. Invasive angiography revealed an incidental coronary artery fistula but was unable to depict its course. CT coronary angiography was undertaken to define the course and termination of the fistula. This confirmed a fistulous connection between the left circumflex artery and the superior vena cava that followed the typical course of an S-shaped sinoatrial nodal artery. Even in such an unusual anomaly this case highlights the ability of CT coronary angiography to accurately depict the coronary artery anatomy.

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A coronary artery fistula is an abnormal communication between a coronary artery and a cardiac chamber, great artery or vein. In this report we present an unusual case of a patient who had a fistula between the left circumflex (LCx) artery and the superior vena cava (SVC), which followed the course of an S-shaped sinoatrial nodal artery (SSNA).

Case report

A 41-year-old man presented to the accident and emergency department with chest pain. Initial investigations confirmed an acute posterior myocardial infarction. Invasive coronary angiography was undertaken with a view to primary angioplasty. Angiography demonstrated a stenosis of the mid-segment of a non-dominant "circumflex vessel". In view of the small size of the vessel and symptom resolution, no intervention was performed. However, a large coronary artery fistula was shown arising from the LCx artery. The site of fistulation could not be accurately determined. Therapeutic embolisation of the fistula was considered and a multidetector CT (MDCT) coronary angiography was subsequently performed to accurately characterise the coronary artery fistula (Figure 1).

A prospectively electrocardiogram (ECG)-gated helical cardiac CT was conducted using a Toshiba Aquilion 64-slice multidetector CT (MDCT) (Toshiba Medical Systems Europe BV, the Netherlands). 125 ml of Ultravist 370 (Bayer Schering Pharma, Berkshire, UK) intravenous contrast with a saline flush was used. The injection protocol and scan delay was determined by P3T software (MEDRAD UK Ltd, Cambridgeshire, UK) following a

transit bolus. Total volume CT dose index was 88 mGy and the dose length product was 847 mGy cm⁻¹.

Coronary CT angiography (CTA) confirmed a left dominant system. There was plaque with mild to moderate stenosis of both the right coronary artery (RCA) and left anterior descending (LAD) artery. The LCx artery gave a small obtuse marginal branch, critically stenosed and corresponding to the culprit lesion on conventional angiography. The LCx proper then continued as a large calibre vessel of almost 8 mm in diameter that descended in the posterior atrioventricular groove and then followed a tortuous course. The vessel passed laterally over the posterior surface of the left atrium before turning sharply, cranially coursing beneath the lower left pulmonary vein. The vessel could then be traced crossing the left surface of the left atrium between the left atrial appendage and the superior pulmonary veins to reach the superior surface of the left atrium. The fistula in its final portion passed across to the region of the sinoatrial node (SAN) to terminate by joining the lowermost SVC at the junction with the right atrium. The course taken by the fistulous LCx artery is characteristic of an SSNA. Figure 2 illustrates the similarity in course of an SSNA and the fistula in this case. The fistulous connection with the SVC is illustrated in Figure 3.

Discussion

Coronary artery fistulae (CAF) are usually congenital abnormalities of the coronary arteries that result in a communication between a coronary artery and a cardiac chamber, great artery or vena cava [1]. They have an angiographic incidence of 0.3–0.8% [2], with approximately 55% originating from the RCA, 35% from the left coronary artery and 5% from both [2]. Unlike the case with anomalous arteries, the coronary artery in a CAF usually arises from its normal location. The most common sites of origin are the RCA and LAD artery,

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Figure 1. Right anterior oblique projection from invasive coronary angiography demonstrating coronary artery fistula arising from left circumflex artery.

with fistulae from the LCx artery being rare. The fistulae tend to drain to low-pressure sites, usually the right ventricle. Drainage to the SVC occurs in only 1% [2]. The clinical presentation of coronary artery fistulae varies, with most adult patients being asymptomatic [1, 2]. The

likelihood of symptoms increases with the degree of left-to-right shunt [2], patients with large shunts typically present with cardiac failure. Traditionally the diagnosis of CAF has been made by a combination of echocardiography and invasive angiography [1]; however, the drainage site can be difficult to appreciate with these imaging modalities. As in many areas of cardiac imaging, new advances in MDCT present an appealing non-invasive means to diagnose CAF. Dodd et al [1] recently reported the utility of 64-slice MDCT in depicting the origin, course and distal drainage of CAF. Therefore, analysis of cardiac CT should routinely include a search for coronary artery anomalies including potential CAF [3]. The treatment of CAF is controversial [2, 3]. Anti-platelet therapy and bacterial endocarditis prophylaxis are recommended. Closure is indicated for symptom control [2] either by traditional surgical ligation or more recently by transcatheter embolisation [2, 3], the early results for either therapeutic approach are equally good [2].

In our case, initial invasive coronary angiography demonstrated a coronary artery fistula but was unable to clearly depict its course and termination. Subsequent ECG-gated MDCT coronary angiography revealed the fistula passed via a tortuous course from the LCx characteristic of SSNA variant to join the lower-most SVC.

The anatomy of the blood supply to the SAN is important; not only does it affect the clinical expression of ischaemic heart disease but it may also affect planning of cardiac surgery and catheter-based interventional cardiac procedures. The SAN artery most often arises as a small branch from the RCA, but in 40% of patients it originates from the LCx [4, 5]. If it arises from the LCx then in approximately one-third of cases the SAN artery adopts a long S-shaped course [6]. The SSNA has three potential origins as described by Nerantzis and Avgoustakis [6]. It may arise as a branch of a long LCx artery or as an upper division or continuation of a short

(a)

(b)

Figure 2. (a) Three-dimensional volume rendered angiographic image from a male patient with exertional fatigue demonstrating the typical course of a normal S-shaped sinoatrial nodal artery (SSNA) (straight arrow). (b) Three-dimensional volume rendered angiographic image demonstrating the coronary arteries from the presented case. The fistulous circumflex artery is seen as a large calibre vessel following the typical course of a SSNA (straight arrow). The curved arrow in each image demonstrates the normal left anterior descending artery.

Figure 3. Coronal oblique maximum intensity projection image from the presented case demonstrating drainage of the fistula into the superior vena cava (arrow).

LCx artery. From its origin the SSNA curves upward and backward to attain the lateral or posterolateral wall of the left atrium before turning sharply and running forward to pass below the lower left pulmonary vein [3]. The SSNA then passes between the pulmonary veins and the left auricle to reach the upper surface of the left atrium at the interatrial septum [6]. It then passes back along the interatrial septum to end either in the sinoatrial nodal area or in the posterior right atrium [6]. The SSNA has three possible terminal routes to the SAN [7]. Most commonly it passes posterior to the SVC, but it may also pass anterior to the SVC or terminate in a series of branches which surround the SVC [7]. The SSNA is generally a larger and longer vessel than the usual SAN artery [7] and supplies not only the SAN but also a large area surrounding myocardium [6, 7]. In addition, it may be the sole blood supply to the SAN [7] and, as such, injury or disease of the vessel can have significant clinical implications.

This case presents what we believe to be a previously unreported finding of a CAF arising as a continuation of the LCx and following the course of a SSNA to terminate in the SVC. Even in such an unusual situation, MDCT is capable of accurately depicting the origin, course and drainage of a CAF and provides important information to help both diagnosis and treatment planning. MDCT highlighted the potential deleterious effects of embolisation of the fistula, as it may have served as the sole blood supply to the SAN.

Conflicts of interest

Dr Giles Roditi is a General Electric company speaker, Guerbet SA speaker, Bracco Group speaker and Bayer AG speaker.

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