CASE REPORT

Aberrant right bronchial artery originating from right coronary artery – MDCT angiography findings

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ABSTRACT. Aberrant bronchial arteries are rarely seen and may originate from various vascular structures. In our case, a 48-year-old man with recurrent chest pain underwent multidetector CT (MDCT) coronary angiography. MDCT images demonstrated an aberrant right bronchial artery originating from the right coronary artery. To our knowledge, this is the first case report of an aberrant right bronchial artery originating from the right coronary artery.

Received 26 April 2008
Revised 24 June 2008
Accepted 28 2008

DOI: 10.1259/bjr/49596063

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Radiology

Bronchial arteries that originate outside the area between the T5 and T6 vertebrae at the level of the major bronchi are considered to be anomalous [1, 2]. These aberrant bronchial arteries may originate from the aortic arch, internal mammary artery, thyrocervical trunk, subclavian artery, costocervical trunk, brachiocephalic artery, pericardiophrenic artery, inferior phrenic artery or abdominal aorta [2].

Vascular connections between coronary arteries and extra-cardiac vascular structures are commonly called fistulae, but few of them feature fistulous high flow and few, if any, have any effect upon coronary functioning [3].

We could not find a report on an aberrant bronchial artery originating from coronary arteries in the peer reviewed literature. There are only a few reports in the literature about abnormal connections between the coronary arteries and the bronchial arteries with a normal origin [4–7]. In this article we provide for the first time MDCT angiographic images and a detailed description of a bronchial artery originating from a proximal right coronary artery.

Case report

A 48-year-old man with recurrent chest pain was admitted to our hospital's cardiology unit. Although the physical examination was within normal limits, there were subtle ECG changes suggesting inferior ischaemia. Transthoracic echocardiographic examination of the patient was normal. With suspicion of coronary artery disease, he was referred for a MDCT angiography of the coronary arteries, as he was reluctant to undergo catheter angiography of the coronary arteries. The patient was

scanned with a 16-detector CT scanner (Philips Medical Systems MX 8000 IDT Multislice CT System-V 2.5). Scan parameters were 120 kV, 340 mAs, 420 ms rotation time with a slice thickness of 1 mm and increments of 0.5 mm, using a detector collimation of 16 × 0.75 mm (pitch: 0.2). 100 ml of non-ionic, iodinated, low-osmolar contrast medium (Omnipaque® 350 mgI/ml) was injected through the antecubital vein at a rate of 5 ml⁻¹s. Subsequently, a bolus of 40 ml saline solution was administered at a rate of 2.5 ml⁻¹s to avoid contrast artefact at the right atrial entrance. An automatic bolus tracking method was used to optimise visualisation. An oral β -blocker, propranolol hydrochloride, was used starting from 2 days before the MDCT examination with a dose of 90 mg tid, with the last dose being taken an hour before the examination. The heart rate was 63 beats per min during the acquisition. The calculated mean CTDI_{vol}, DLP and effective dose were 35.7 mGy, 643 mGy cm and 10.9 mSv, respectively, for the this scan.

Images were reconstructed by using retrospective electrocardiographic gating. Coronary arteries were evaluated with post-processed images obtained by multiplanar reformation, maximum intensity projection and volume rendering techniques based on the axial scan (computerised tomographic angiography; CTA).

An MDCT scan demonstrated a normal left main coronary artery. The proximal left anterior descending artery (LAD) was mildly stenotic owing to mixed type atherosclerotic plaques. At bifurcation, where the first diagonal artery arises from LAD, there were subtle, calcified, atherosclerotic plaques. Distal LAD and diagonal arteries were normal. Proximal part of the left circumflex artery (LCx) and obtuse marginal branches were normal, but a tiny calcified plaque was evident in the middle part of the LCx. A conus artery was originating from the right coronary sinus. The diameter and contrast enhancement of the right coronary artery (RCA) were normal (Figure 1a).

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CTA also revealed an abnormal artery originating from the proximal segment of RCA and coursing parallel to the right main bronchus. This vascular structure was ending distal to the right hilum and its terminal branches were spreading towards the peribronchovascular interstitium. No other vascular structure supplying the right bronchial system was seen in the field of view despite meticulous exploration of the raw axial and reconstructed multiplanar CTA images. As the CTA images covered the normal origins of both bronchial arteries (T5 to T6 thoracic aortic levels ± 1 level), we considered that the anomalous artery represented an aberrant right bronchial artery originating from the right coronary artery, given its parallel course to the right main bronchus and its terminal distribution (Figure 1a, b, c, d). There was a left bronchial artery originating normally from the thoracic aorta (Figure 1c, 1d).

The patient's complaints were atypical and a $^{99}\text{Tc}^{\text{m}}$ MIBI-SPECT imaging (myocardial perfusion scintigraphy) coupled with treadmill exercise stress test was not convincing for ischaemia). Therefore, conservative management was chosen. The patient did not have any complications in the following 18 months.

Discussion

The bronchial arteries supply the trachea, extra- and intrapulmonary airways, bronchovascular bundles, nerves, supporting structures, regional lymph nodes, visceral pleura and oesophagus, as well as the vasa

vasorum of the aorta, pulmonary arteries and pulmonary veins [8].

The bronchial arteries may show anatomical variations in terms of origin, branching pattern and course [9]. The bronchial arteries normally originate directly from the descending thoracic aorta, most commonly between the levels of the T5 and T6 vertebrae [10]. Cauldwell et al [1] classified classic bronchial artery branching patterns in four groups: two on the left and one on the right that presents as an intercostobronchial trunk (ICBT) (40% of cases); one on the left and one ICBT on the right (21%); two on the left and two on the right (one ICBT and one bronchial artery) (20%); and one on the left and two on the right (one ICBT and one bronchial artery) (9.7%). The right ICBT is the most common vessel seen at angiography (80% of individuals). The right ICBT usually originates from the right posterolateral aspect of the thoracic aorta and the normal right and left bronchial arteries from the anterolateral aspect of the aorta. Right and left bronchial arteries that arise from the aorta as common trunk are not uncommon at angiography, but the prevalence of a common bronchial artery trunk is unknown [1].

Bronchial arteries that arise from any origin other than the thoracic aorta between the T5 and T6 vertebrae at the level of the major bronchi are considered to be anomalous [1, 2]. The prevalence of bronchial arteries with an anomalous origin is reported between 8.3% and 35% [2, 11]. These aberrant bronchial arteries may originate from the aortic arch, internal mammary artery, thyrocervical trunk, subclavian artery, costocervical

Figure 1. A right bronchial artery originating from the RCA in a 48-year-old man is well demonstrated on curved multiplanar reformat (MPR) image (a), curved maximum-intensity-projection (MIP) image (b), and oblique sagittal MIP images (c, d). Whereas the LMCA and LCx (short black arrow) are normal, the proximal LAD (short white arrow) is seen to be mildly stenotic in a 1.5 cm segment owing to mixed type atherosclerotic plaques (a). The caliber and course of the RCA (long white arrows) are normal, but an aberrant right bronchial artery (long black arrows) is seen to originate from the proximal segment of the RCA and eventually to reach the bronchi (a,b,c,d). The left bronchial artery (black arrowheads) is located in its normal anatomical location and originates from the thoracic aorta as expected (c, d). (A=aorta, PA=pulmonary artery, asterisk=left main bronchus).

trunk, brachiocephalic artery, pericardiophrenic artery, inferior phrenic artery or abdominal aorta. Aberrant bronchial arteries can be distinguished anatomically and angiographically from non-bronchial systemic collateral vessels according to their course along the major bronchi. In contrast, non-bronchial systemic collateral vessels enter the pulmonary parenchyma through the adherent pleura or by way of the pulmonary ligament, and their course is not parallel to that of the bronchi [2]. Most of the aberrant bronchial arteries arise from the aortic arch [2, 3]. The prevalence of bronchial arteries with origins outside the aorta is unknown.

Until now, an aberrant bronchial artery originating from the coronary artery has not been reported. However, there are a few reports in the literature about fistulae between coronary arteries and normally originating bronchial arteries [4–7]. Vascular connections between coronary arteries and extra-cardiac structures (such as bronchial arteries) are commonly called fistulae, but few of them feature fistulous flow and few, if any, have an effect upon coronary functioning [3].

In a recent review, it was suggested that there is a need to differentiate abnormal or rare connections between two vascular structures without fistulous flow (e.g. coronary artery to left ventricle, or circumflex artery to right coronary artery) from abnormal connections between two vascular structures with fistulous flow. A true fistula of the circulatory system is characterised by a clearly ectatic vascular segment that exhibits fistulous flow and connects two vascular territories governed by widely variant haemodynamic environments (large pressure differences) [3]. We would like to emphasise our belief, however, that the ectasia in this definition is not a prerequisite but, rather, an end result of long-term existence of high flow.

Collateral or aberrant-origin arteries connect two neighbouring systemic arteries, or they may connect two vascular territories at different pressure, by means of a high-resistance tract with a comparatively narrow lumen. These are not called fistulae [3, 12]. When the conflicting opinions in this subject are reconciled, two main reasons why these should not be called fistulae are (1) absence of a huge pressure difference (there is a small pressure gradient which from time to time changes from one direction to the other, allowing reversal of flow direction) and (2) absence of ectatic appearance of such vessels (as the tortuosity or ectasia usually develops in the case of a long-term consistent pressure difference along a high-flow fistula).

As it requires a high index of suspicion to catheterise an anomalous vessel with an aberrant origin, detection of coronary artery anomalies by conventional coronary angiography remained an incidental finding before MDCT angiography of the coronaries gained popularity. MDCT coronary angiography has recently become the gold standard, particularly for depicting the anatomical variations and anomalies of the coronary arteries, because this technique can globally show the origin and path of the anomalous arteries [13, 14].

Following the introduction of ultimate MDCT equipment with high temporal and spatial resolution, better depiction of the coronary arteries has been possible. In addition to vessel lumen, the arterial wall can be evaluated with the help of MDCT images, which is an

advantage over conventional coronary angiography. Reformatted and volume-rendered images of MDCT facilitate understanding of malformations and anatomical variations.

In our case, the left bronchial artery originated normally from the descending aorta, whereas a normally arising right bronchial artery could not be detected. Instead, there was an aberrant artery originating from the RCA and supplying the right bronchial territory. There was no ectatic tortuous segment that could be a secondary sign of long-term high-flow fistula (*i.e.* a consistently high pressure difference between the connected vascular systems). Based on these findings, we consider that the relationship between the RCA and the right bronchial artery is an aberrant origin anomaly rather than a fistulisation. This assumption would also help to explain the patient's inconsistent complaints and atypical angina, since a high-flow fistulous steal from the RCA would probably result in more consistent symptoms and/or laboratory findings.

There are several reports on coronary vessel variations with steal phenomenon as a rare cause of angina [15, 16]. Particularly, a bronchial artery side branch originating from the left internal mammary artery in a patient with LIMA–LAD anastomosis was found to steal enough blood flow to cause angina [17]. Hence, the presented abnormality in this case report may represent one of the rare aetiologies of angina.

In conclusion, a bronchial artery with aberrant origin from the coronary arteries should be kept in mind and should be considered as a rare finding during MDCT examinations of the coronaries performed in work-up for recurrent, atypical chest pain, as it may be a cause of angina due to occasional steal phenomenon.

References

1. Cauldwell EW, Siekert RG, Lininger RE, Anson BJ. The bronchial arteries: an anatomic study of 105 human cadavers. *Surg Gynecol Obstet* 1948;86:395–412.
2. Sancho C, Escalante E, Dominguez J, Vidal J, Lopez E, Valdeperas J, et al. Embolization of bronchial arteries of anomalous origin. *Cardiovasc Intervent Radiol* 1998;21:300–4.
3. Angelini P, Villason S, Chan AV, Diez JG. Normal and anomalous coronary arteries in humans. In: Angelini P, editor. *Coronary artery anomalies: a comprehensive approach*. Philadelphia: Lippincott Williams & Wilkins, 1999:27–150.
4. Lorusso R, De Cicco G, Faggiano P, Chiari E, Nardi M, Curello S, et al. Coronary-to-bronchial anastomosis: an unusual cause of hemoptysis. *J Cardiovasc Med* 2007;8:642–4.
5. Peynircioglu B, Ergun O, Hazirolan T, Cil BE, Aytemir K. Bronchial to coronary artery fistulas: an important sign of silent coronary artery disease and potential complication during bronchial artery embolization. *Acta Radiol* 2007;48:171–2.
6. Boudou N, Elbaz M, Kouaho S, Cherradi R, Maupas E, Carrie D, et al. Coronary-bronchial artery fistula and two-vessel coronary disease treated by embolisation of the anastomosis and coronary angioplasty. *Arch Mal Coeur Vaiss* 2005;98:677–9.
7. Avsar O, Demir I, Ekiz O, Yilmaz H. Coronary artery fistula from the left circumflex artery to the right bronchial artery. *Anadolu Kardiyol Derg* 2005;5:56–8.

8. Deffenbach ME, Charan NB, Lakshminarayan S, Butler J. The bronchial circulation: small, but a vital attribute to the lung. *Am Rev Respir Dis* 1987;135:463–81.
9. Lippert H, Pabst R. Bronchial arteries. In: Lippert H, Pabst R, eds. *Arterial variations in man*. Munich, Germany: Bergmann Verlag, 1985:18–19.
10. Marshall TJ, Jackson JE. Vascular intervention in the thorax: bronchial artery embolization for hemoptysis. *Eur Radiol* 1997;7:1221–7.
11. Cohen AM, Doershuk CF, Stern RC. Bronchial artery embolization to control hemoptysis in cystic fibrosis. *Radiology* 1990;175:401–5.
12. Angelini P. Coronary-to-Pulmonary Fistulae: What are they? What are their causes? What are their functional consequences? *Tex Heart Inst J* 2000;27:327–9.
13. van Ooijen PM, Dorgelo J, Zijlstra F, Oudkerk M. Detection, visualization and evaluation of anomalous coronary anatomy on 16-slice multidetector-row CT. *Eur Radiol* 2004;14:2163–71.
14. Duran C, Kantarci M, Durur Subasi I, Gulbaran M, Sevimli S, Bayram E, et al. Remarkable anatomic anomalies of coronary arteries and their clinical importance: a multi-detector computed tomography angiographic study. *J Comput Assist Tomogr* 2006;30:939–48.
15. Elias-Smale SE, Roeffel SM. Angina caused by coronary steal phenomenon. *Int J Cardiol* 2007;116:42–3.
16. Gur M, Yilmaz R, Demirbag R. Unidirectional communication between the circumflex and right coronary arteries: a very rare coronary anomaly and cause of ischemia. *Int J Cardiovasc Imaging* 2006;22:339–42.
17. Paelinck B, Kunnen J, Van den Branden F, Vermeersch P. Transcatheter embolization of a bronchial side branch of the internal mammary artery for the treatment of a coronary steal phenomenon. *Cathet Cardiovasc Diagn* 1996;38:289–91.