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BRIEF ARTICLE

Aortic ostia of the bronchial arteries and tracheal bifurcation: MDCT analysis

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Abstract

AIM: To explore the anatomical relationships between bronchial artery and tracheal bifurcation using computed tomography angiography (CTA).

METHODS: One hundred consecutive patients (84 men, 16 women; aged 46-85 years) who underwent CTA using multi-detector row CT (MDCT) were investigated retrospectively. The distance between sites of bronchial artery ostia and tracheal bifurcation, and dividing directions were explored. The directions of division from the descending aorta were described as on a clock face.

RESULTS: We identified ostia of 198 bronchial arteries: 95 right bronchial arteries, 67 left bronchial arteries, 36 common trunk arteries. Of these, 172 (87%) divided from the descending aorta, 25 (13%) from the aortic arch, and 1 (0.5%) from the left subclavian artery. The right, left, and common trunk bronchial arteries divided at -1 to 2 cm from tracheal bifurcation with frequencies of 77% (73/95), 82% (54/66), and 70% (25/36), respectively. The dividing direction of right bronchial arteries from the descending aorta was 9 to 10 o'clock with a frequency of 81% (64/79); that of left and common tract bronchial arteries was 11 to 1 o'clock with frequencies of 70% (43/62) and 77% (24/31), respectively.

CONCLUSION: CTA using MDCT provides details of the relation between bronchial artery ostia and tracheal bifurcation.

Key words: Anatomy; Computed tomography; Bronchial artery; Medical imaging; Tracheal bifurcation

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INTRODUCTION

Following recent advances in multi-detector row computed tomography (MDCT), which enables rapid visualization of thin-slice images with good resolution, computed tomography angiography (CTA) with MDCT is increasingly being used to identify the artery responsible for hemoptysis[1-6]. Although in some instances non-bronchial arteries are involved in hemoptysis[1,7,8], the main source of hemoptysis is a bronchial artery[9]. Most interventional radiologists would be familiar with the dividing sites of the bronchial arteries based on their experience and on trial and error, but they may encounter difficulty in catheterization of the bronchial artery. The relationships between the origin of bronchial arteries and the thoracic vertebrae are known from early studies[10,11]. Remy-Jardin *et al*[1] coded bronchial arteries originating from the descending aorta between the T5 and T6 vertebral levels as orthotopic, and those originating outside levels T5-T6 as ectopic. However, because the tracheal bifurcation is visible fluoroscopically but the exact thoracic vertebral level is difficult to identify, it is clinically useful to know how the bronchial artery ostia relate to tracheal bifurcation rather than to the thoracic vertebrae. Dilatation of bronchial arteries and the development of collateral arteries are observed in patients with hemoptysis[1-4]. In the present study, we explored the intact relation between bronchial artery ostia and tracheal bifurcation among a population with no cause to have enlarged bronchial arteries.

The purpose of this study is to explore the anatomical relationships between bronchial artery ostia and tracheal bifurcation using CTA with MDCT.

MATERIALS AND METHODS

Patients

The study was approved by the Ethics Committee of our institution, and informed consent was obtained from all patients. One hundred consecutive patients (84 men, 16 women; mean age, 68.6 years; age range, 46-85 years) with esophageal cancer who received dynamic CT between February 2009 and May 2010 were investigated retrospectively. No patient had an episode of hemoptysis; all underwent contrast-enhanced helical MDCT of the thorax for the purpose of identifying the esophageal and bronchial arteries prior to surgical treatment. The relation between the tracheal bifurcation and the bronchial arteries was analyzed using the same data that are obtained in MDCT of the thorax at our institute. Care was taken to avoid administration of contrast medium to patients with renal insufficiency (creatinine level > 1.5 mg/L) or iodine allergy.

MDCT protocol and contrast medium injection

CTA was conducted using an MDCT scanner (LightSpeed VCT 64, General Electric Healthcare, Milwaukee, WI) with a 64 mm × 0.625 mm detector configuration in which interspaced helical data sets were collected from 64 detector rows. The following parameters were used for unenhanced CT and the two phases of contrast-enhanced CT: gantry rotation speed of 0.5 s per rotation, 0.5 mm collimation, 15 mm/s table increment with helical pitch of 15, tube voltage of 120 kV, and tube current of 300 mA. Axial sections (0.5 mm thickness) were reconstructed at 0.5 mm intervals. The following MDCT protocol was employed for evaluation of the thorax. Using an automatic injector (Dual Shot GX, Nemotokyorindo, Tokyo, Japan), each patient received an intravenous bolus of nonionic contrast medium at 580 mg I/kg of patient body weight, containing 300 mg I/mL (Omnipaque, Daiichisankyo Pharmaceutical, Tokyo, Japan), for a duration of 25 s, through a 20-gauge angiocatheter placed in the antecubital vein.

The automatic bolus tracking method was used with Smart Prep software (GE Healthcare) to monitor contrast enhancement after injection of contrast medium. Unenhanced scans were obtained initially, and a region-of-interest cursor for bolus tracking was then placed in the ascending aorta. Scans were obtained from the level of the thoracic inlet to the caudal edge of the kidney. The triggering threshold CT value was set at 200 HU, and real-time low-dose (120 kVp, 50 mA) serial scanning for monitoring began 6 s after the start of the contrast medium injection. Two phases (arterial and venous) were obtained during breath-holding in each. The arterial phase was automatically performed after the CT value reached the triggering threshold of 200 HU. The following images were systematically reconstructed from the arterial phase data: contiguous transverse scans of thickness 0.5 mm viewed on mediastinal and lung window settings, oblique coronal and sagittal maximum intensity projections (MIPs), and three-dimensional volume-rendered images of the thoracic vascular structures. The venous phase was not utilized in this study.

Data analysis and image interpretation

The large number of images was interpreted at a remote workstation and analyzed using Aquarius NET (TeraRecon, Sanmateo, CA). Three radiologists, each with 3 to 15 years of experience in CT image interpretation, performed image evaluation in consensus. CT values were measured at four points in the aorta: at the level of the ascending aorta, arch, descending aorta, and diaphragm. CT interpretation focused on evaluation of the bilateral bronchial arteries. Transverse slices from thoracic CTA were used in combination with the multiplanar reformatted images to identify dividing of the bronchial artery from the thoracic aorta and the aortic arch. The borderline between the aortic arch and the descending aorta was defined as the bottom of the aortic arch, as delineated on thoracic CT. The distance between this borderline and the line of tracheal bifurcation was measured. The level of tracheal bifurcation was termed ‘0 level’. Positive values were defined as the cranial distance from the tracheal bifurcation and negative values as the caudal distance. Arteries that progressed along the bronchus were identified as bronchial arteries. All bronchial arteries dividing from the aortic arch and descending aorta were followed using the transverse slice images. If the bronchial arteries could not be identified, three-dimensional MIP reformatted images in the coronal, sagittal, and oblique planes were used to search for tortuous bronchial arteries as they followed the bronchial tree from their origin at the aorta or other systemic artery. The frequency of intercosto-bronchial trunk was explored because the anterior spinal artery can arise from an intercosto-bronchial artery, and thus must be identified.

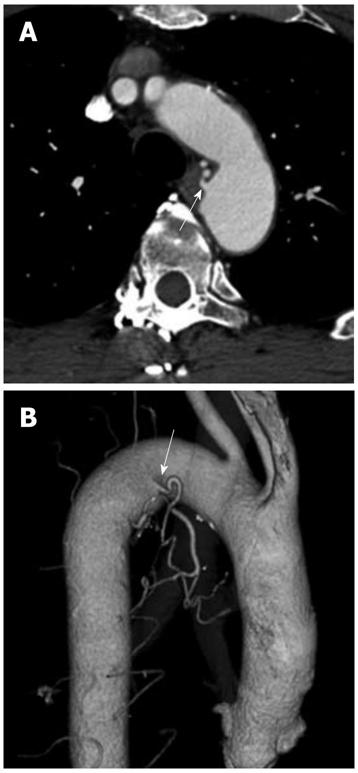

Figure 1 Common trunk of the right and left bronchial arteries from the aortic arch is indicated by arrows on an axial computed tomography image with mediastinal soft-tissue window settings (A) and on a thin-section maximum intensity projection image of a three-dimensional volumetric reformatted image (B).

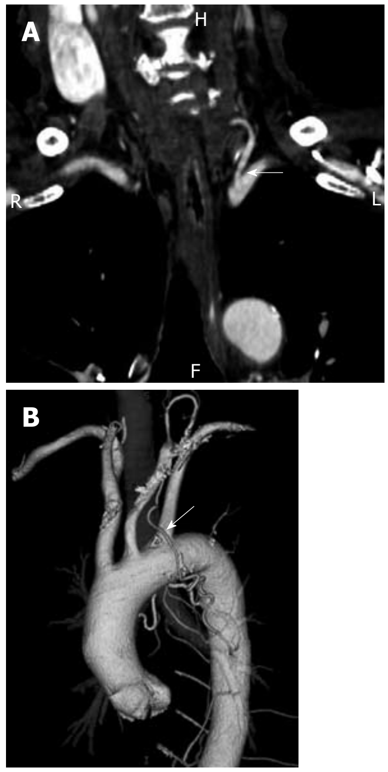

Figure 2 Left bronchial artery arising from the left subclavian artery is indicated by arrows on a reformatted coronal computed tomography image with mediastinal soft-tissue lung window settings (A) and on a thin-section maximum intensity projection image of a three-dimensional volumetric reformatted image (B).

First, dividing sites of the bronchial arteries from the aorta, dividing style (genuine or common trunk), and the number of bronchial arteries were explored. Second, the distance between the site of bronchial artery dividing and tracheal bifurcation was measured on the transverse 0.5 mm thick slices. Third, the dividing directions of the bronchial arteries from the descending aorta were explored using the transverse slice images. The directions of division from the descending aorta were described in terms of positions of the numbers on a clock face. In bronchial arteries that divided from the aortic arch, the dividing directions were described as right caudal, middle caudal, and left caudal.

RESULTS

CT values in the aorta

In the 100 subjects, mean CT values (HU) at the level of the ascending aorta, aortic arch, descending aorta, and diaphragm were 389 ± 71, 364 ± 65, 374 ± 66, and 353 ± 68, respectively.

Aortic sites of bronchial artery ostia

We identified 198 aortic sites of bronchial artery ostia in the 100 subjects. Of these, 172 (87%) divided from the descending aorta, 25 (13%) from the aortic arch (Figure 1), and 1 (0.5%) from the left subclavian artery (Figure 2).

Dividing style of right and left bronchial arteries, and frequency of intercostal artery sub-branching

Of the 198 dividing sites, 95 divided as right bronchial arteries, 67 as left bronchial arteries, and 36 as a common trunk of right and left bronchial arteries. Of the 95 right bronchial arteries, 28 divided independently as a genuine right branch and 67 (71%) divided as a common trunk of right bronchial and intercostal arteries (Figure 3). Of the 67 left bronchial arteries, 65 divided independently as a genuine left branch and 2 (3%) divided as a common trunk of left bronchial and intercostals arteries. Of the 36 common trunk arteries, 34 divided as a common trunk of right and left bronchial arteries, and 2 (6%) divided as a common trunk of right and left bronchial arteries, and intercostal arteries. No anterior spinal artery was delineated from intercostal arteries that divided from either common trunk.

Identified numbers of right and left bronchial arteries

We could not identify a right bronchial artery in 1 subject or a left bronchial artery in 9 subjects. A total of 234 bronchial arteries were identified: 131 (95 plus 36) right bronchial arteries, and 103 (67 plus 36) left bronchial arteries.

A singular right bronchial artery was observed in 68 subjects, dual right bronchial arteries in 30 subjects, and triple right bronchial arteries in 1 subject. The average

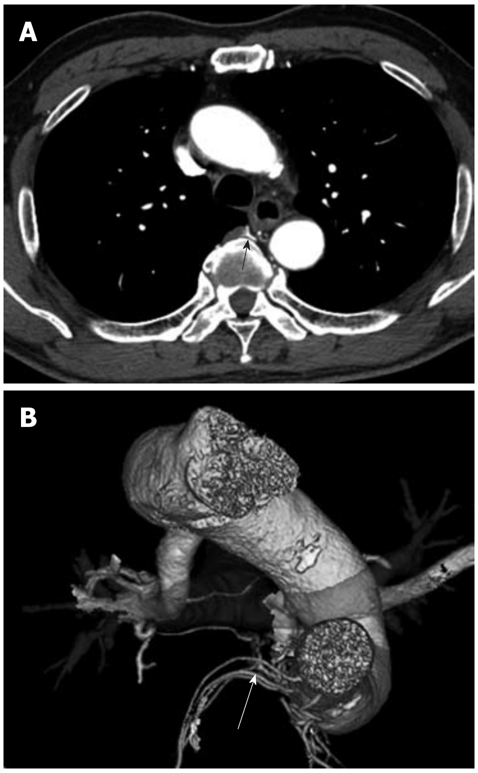

Figure 3 Right bronchial artery branches with an intercostal artery (arrow) at the approximate ventral center of the thoracic vertebra, shown on an axial computed tomography scan with mediastinal soft-tissue window settings (A) and on a thin-section maximum intensity projection image of a 3D volumetric reformatted image (B).

number of right bronchial arteries was 1.31 per subject. A singular left bronchial artery was observed in 79 subjects and dual left bronchial arteries in 12 subjects. The average number of left bronchial arteries was 1.03 per person.

Dividing sites of bronchial arteries related to tracheal bifurcation and their dividing directions

Of the 234 bronchial arteries, 15 divided from the aortic arch and 219 divided from the descending aorta. The mean border line between the aortic arch and descending aorta was at the level 18.4 ± 7.4 mm cranial to the tracheal bifurcation in the 100 subjects.

Figure 4 shows the relation between the right bronchial artery ostia and the tracheal bifurcation. Of the 95 right bronchial arteries, 29 (31%) divided at a level 0-1 cm cranial to the bifurcation, 60 (64%) at 0-2 cm cranial, and 13 (13%) at -1 to 0 cm caudal to the bifurcation. A total of 73 (77%) right bronchial arteries divided at between -1 and 2 cm from the bifurcation (Table 1).

The dividing directions of the right bronchial arteries are shown in Figure 4. Of the 79 right bronchial arteries that divided from the descending aorta, 64 (81%) divided in the direction of 9 to 10 o'clock (Table 2). Of the 16 right bronchial arteries that divided from the aortic arch, 13 (81%) divided in the right caudal direction, 2 in the left caudal direction, and 1 in the central caudal direction (Table 3).

Table 1 Relation between bronchial arteries ostia from aorta and tracheal bifurcation *n* (%)

Level from tracheal bifurcation (cm)	Right bronchial artery	Left bronchial artery	Common tract artery
≥ 4, < 4.5	0 (0)	0 (0)	2 (6)
≥ 3.5, < 4	2 (2)	0 (0)	1 (3)
≥ 3, < 3.5	0 (0)	0 (0)	0 (0)
≥ 2.5, < 3	7 (7)	5 (8)	2 (6)
≥ 2, < 2.5	7 (7)	4 (6)	2 (6)
≥ 1.5, < 2	14 (15)	9 (14)	3 (8)
≥ 1, < 1.5	17 (18)	3 (5)	6 (17)
≥ 0.5, < 1	15 (16)	10 (15)	2 (6)
≥ 0, < 0.5	14 (15)	20 (30)	7 (19)
≥ -0.5, < 0	6 (6)	6 (9)	1 (3)
≥ -1, < -0.5	7 (7)	6 (9)	6 (17)
≥ -1.5, < -1	3 (3)	0 (0)	4 (11)
≥ -2, < -1.5	1 (1)	3 (5)	0 (0)
≥ -2.5, < -2	0 (0)	0 (0)	0 (0)
≥ -3, < -2.5	2 (2)	0 (0)	0 (0)
Total (*n* = 197)	95	66	36

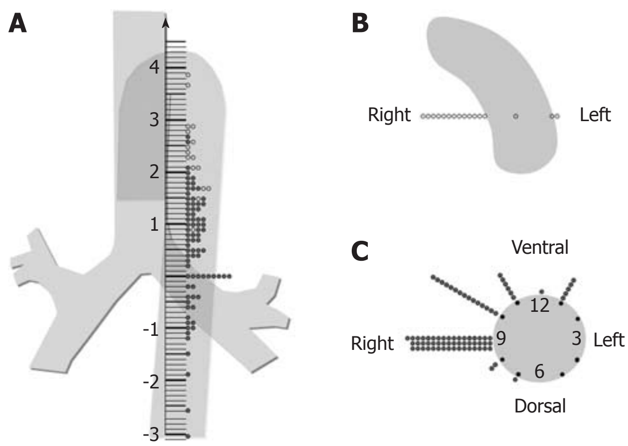

Figure 4 Diagram showing the relation of the tracheal bifurcation to the right bronchial artery ostia, coronal aspect (A), and dividing directions of the right bronchial artery from the aortic arch (B) and from the descending aorta (C), axial aspect.

Figure 5 shows the relation between the left bronchial artery ostia and the tracheal bifurcation. Of the 66 left bronchial arteries, 33 (50%) divided at a level 0-1 cm cranial to the bifurcation, 42 (64%) at 0-2 cm cranial, and 12 (18%) at -1 to 0 cm caudal to the bifurcation. A total of 54 (82%) left bronchial arteries divided at between -1 and 2 cm from the bifurcation.

The dividing directions of the left bronchial artery are shown in Figure 5. Of the 62 left bronchial arteries that divided from the descending aorta, 43 (70%) divided in the direction of 11 to 1 o'clock and 18 (29%) divided at the direction of 9 to 10 o'clock (Table 2). All 4 of the left bronchial arteries that divided from the aortic arch did so in the right caudal direction (Table 3).

The relation between the ostia of the aortic common trunk bronchial arteries and the tracheal bifurcation is shown in Figure 6. Of the 36 common tract bronchial arteries, 9 (25%) divided at a level 0-1 cm cranial to the bifurcation, 18 (50%) at 0-2 cm cranial, and 7 (20%) at -1 to 0 cm caudal to the bifurcation. A total of 25 (70%)

Table 2 Dividing direction of bronchial arteries from descending aorta *n* (%)

	Time o'clock direction								
Artery	7	8	9	10	11	12	1	2	Total
Right bronchial	1 (1)	2 (3)	49 (62)	15 (19)	6 (8)	1 (1)	5 (6)	0 (0)	79
Left bronchial	0 (0)	0 (0)	11 (18)	7 (11)	11 (18)	21 (34)	11 (18)	1 (2)	62
Common tract	0 (0)	0 (0)	4 (13)	3 (10)	5 (16)	14 (45)	5 (16)	0 (0)	31

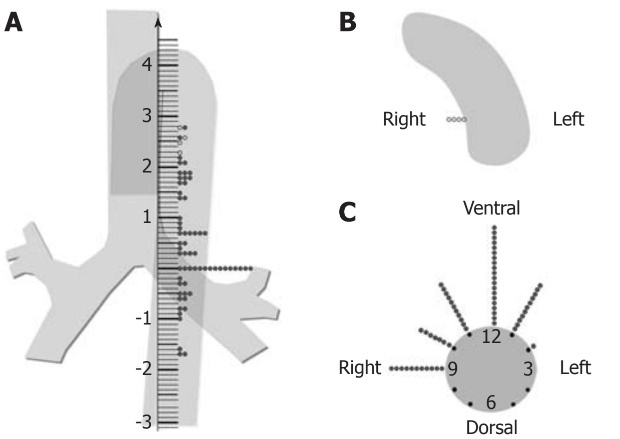

Figure 5 Diagram showing the relation of the tracheal bifurcation to the left bronchial artery ostia, coronal aspect (A), and dividing directions of the left bronchial artery from aortic arch (B) and from the descending aorta (C), axial aspect.

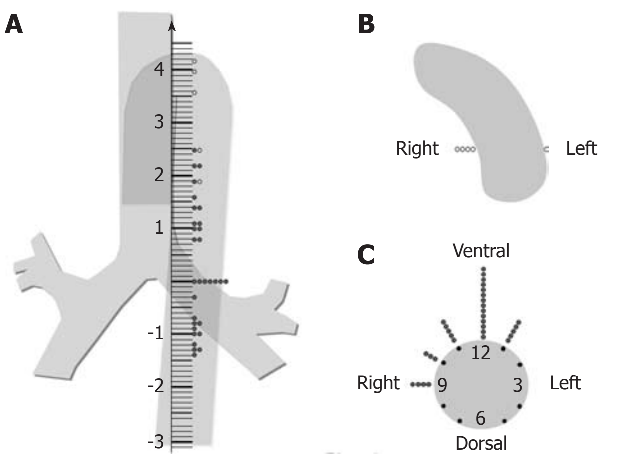

Figure 6 Diagram showing the relation of the tracheal bifurcation to common trunk ostia of the right and left bronchial arteries, coronal aspect (A), dividing directions of the common trunk from the aortic arch (B) and from the descending aorta (C), axial aspect.

common tract bronchial arteries divided at a level between -1 and 2 cm from the bifurcation.

The dividing directions of the common tract bronchial artery are shown in Figure 6. Of the 31 common tract bronchial arteries that divided from the descending aorta, 24 (77%) divided in the direction of 11 to 1 o'clock and 7 (23%) divided at the direction of 9 to 10 o'clock (Table 2). Of the 5 common tract bronchial arteries that divided from the aortic arch, 4 (80%) divided in the right caudal direction and 1 (20%) in the central caudal direction (Table 3).

Table 3 Dividing direction of bronchial arteries from aortic arch *n* (%)

Artery	Direction			Total
	Right caudal	Left caudal	Middle caudal	
Right bronchial	13 (81)	2 (13)	1 (6)	16
Left bronchial	4 (100)	0 (0)	0 (0)	4
Common tract	4 (80)	0 (0)	1 (20)	5

Table 4 Comparisons of bronchial artery findings between pathological and multi-detector row computed tomography studies *n* (%)

	Pathological study	MDCT study	
	Kasai *et al*[10]	Morita *et al*[5]	Present study
Right bronchial artery	*n* = 161	*n* = 80	*n* = 96
Direct origin from asrta	44 (27)	15 (19)	28 (29)
Intercostal bronchial trunk	86 (53)	61 (76)	67 (70)
Subclavian artery	31 (19)	4 (5)	1 (1)
Left bronchial artery	*n* = 117	*n* = 67	*n* = 67
Direct origin from asrta	111 (95)	63 (94)	65 (97)
Intercostal bronchial trunk	1 (1)	4 (6)	2 (3)
Subclavian artery	5 (4)	0	0
Common trunk of both bronchial arteries	*n* = 65	*n* = 38	*n* = 36
Direct origin from aorta	/	/	34 (94)
Intercostal bronchial trunk	/	/	2 (6)

Data are numbers of right, left and common trunk arteries. Numbers in parentheses are percentages. MDCT: Multidetector row computed tomography.

DISCUSSION

In a postmortem study, Cauldwell *et al*[11] documented that bronchial arteries divided from the aortic arch with an incidence of 17.3%, compared with 13% in the present study. Most bronchial arteries divide from the aorta; however, they can also divide from sites such as the right subclavian artery, left subclavian artery, or their branches. The incidence of dividing from outside the aorta was 0.5% in the present study, 3.3% in a previous MDCT series[5], and 15% in a previous pathological manuscript (Table 4)[11]. Morita *et al*[5] proposed that bronchial arteries arising from the subclavian arteries are likely to go unnoticed on MDCT because of their small diameter. Although limitations exist, the MDCT data regarding dividing sites, styles, and numbers of bronchial arteries are comparable with data acquired in previous postmortem series (Table 5). MDCT studies have the advantage of

Table 5 Numbers of bronchial arteries

	Kasai *et al*[10] (*n* = 370)	Cauldwell *et al*[11] (*n* = 467)	The present study (*n* = 234)
No. of right bronchial arteries			
0	0	0	1 (1)
1	13 (13)	100 (67)	68 (68)
2	57 (57)	48 (32)	30 (30)
3	22 (22)	1 (0.7)	1 (1)
4	6 (6)	1 (0.7)	0
No. of left bronchial arteries			
0	0	0	9 (9)
1	3 (31)	47 (31)	79 (79)
2	59 (59)	93 (62)	12 (12)
3	8 (8)	9 (6)	0
4	2 (2)	1 (0.7)	0

enabling exploration of the relation between the tracheal bifurcation and other body components. The present data (Table 4) regarding bronchial artery division from the aorta are similar to the basic data obtained by Morita *et al*[5], but they did not focus on the relation between the bronchial artery ostia and the tracheal bifurcation.

Previous pathological manuscripts noted that the border between the aortic arch and the descending aorta corresponds to the site of the left recurrent laryngeal nerve[10,11] and that dividing sites of the bronchial arteries correspond to thoracic vertebral levels 5 to 6[10,11]. However, this information is not always useful in the clinical situation of catheter insertion to the bronchial arteries because the position of the X-ray fluoroscopic field changes frequently during catheterization, causing problems in identification of each thoracic vertebral level. The tracheal bifurcation, however, is easily identified. The information obtained in the present study can be used as a reference regarding positioning of the bronchial artery ostia from the aorta with respect to tracheal bifurcation.

During bronchial arterial embolization, it is important to inhibit the migration of embolic material to the spinal artery[7,9], which may occur because the anterior spinal artery communicates with the intercostal arteries. In the present MDCT series, we observed no communication between the anterior spinal artery and the intercostal arteries, probably because of the small diameter of the branches. Intercostal arteries arise from the dorsal aspect of the aorta, while bronchial arteries arise from its ventral aspect. The frequency of a trunk of right bronchial and intercostal arteries is previously reported as 53.4%-66.8%[10,11]; in the present study, this frequency was 70% (67/95) (Table 4), while that of a trunk of left bronchial and intercostal arteries was 3% (2/66), and that of a trunk of common tract and intercostal arteries was 6% (2/36). This difference in frequency between the right, left, and common trunk arteries may be related to the direction of division: i.e. the left bronchial artery and common trunk arteries most commonly divide at 11 to 1 o'clock, while the right bronchial artery most commonly divides at 9 to 10 o'clock. The intercostal arteries divided dorsal to the right bronchial arteries at the approximate center of the thoracic vertebrae (Figure 3). Therefore, during catheterization in BAE, the microcatheter might pass over this dividing point to avoid causing neurological complications.

One of the weaknesses in our MDCT study was the failure to delineate the right bronchial artery in 1 subject and the left bronchial artery in 9 subjects. In a previous MDCT series, Morita *et al*[5] reported that MDCT did not detect 6 small bronchial arteries that were later revealed during surgery. In the present series, the mean CT values on CTA at the level of the ascending aorta, aortic arch, descending aorta, and diaphragm ranged from 389 to 353 HU. A greater density of contrast medium in the aorta and thinner CT slices would improve the detection of small bronchial arteries. Another weakness is that the present study is restricted to patients without any episode of hemoptysis. In contrast, in cases of hemoptysis the responsible bronchial artery is usually dilated and easily delineated on MDCT[2,4].

In conclusion, although we could not demonstrate all of the bronchial arteries on MDCT, CTA using MDCT provides detailed information regarding the relation between bronchial artery ostia and tracheal bifurcation.

COMMENTS

Background

Although relationships between the origin of bronchial arteries and the thoracic vertebrae are known from early studies, it is clinically useful to know how the bronchial artery ostia relate to tracheal bifurcation rather than to the thoracic vertebrae because the tracheal bifurcation is visible fluoroscopically but the exact thoracic vertebral level is difficult to identify.

Research frontiers

The intact relation between bronchial artery ostia and tracheal bifurcation has not been reported yet in a population with no cause to have enlarged bronchial arteries.

Innovations and breakthroughs

Of the 95 right bronchial arteries, 29 (31%) divided at a level 0-1 cm cranial to the bifurcation, 60 (64%) at 0-2 cm cranial, and 13 (13%) at -1 to 0 cm caudal to the bifurcation. A total of 73 (77%) right bronchial arteries divided at between -1 and 2 cm from the bifurcation. Of the 79 right bronchial arteries that divided from the descending aorta, 64 (81%) divided in the direction of 9 to 10 o'clock. Of the 16 right bronchial arteries that divided from the aortic arch, 13 (81%) divided in the right caudal direction, 2 in the left caudal direction, and 1 in the central caudal direction. Of the 66 left bronchial arteries, 33 (50%) divided at a level 0-1 cm cranial to the bifurcation, 42 (64%) at 0-2 cm cranial, and 12 (18%) at -1 to 0 cm caudal to the bifurcation. A total of 54 (82%) left bronchial arteries divided at between -1 and 2 cm from the bifurcation.

Applications

The left bronchial artery and common trunk arteries most commonly divide at 11 to 1 o'clock, while the right bronchial artery most commonly divides at 9 to 10 o' clock. The intercostal arteries divide dorsal to the right bronchial arteries at the approximate center of the thoracic vertebrae. Therefore, during catheterization in BAE, the microcatheter might pass over this dividing point to avoid causing neurological complications.

Terminology

Computed tomography angiography (CTA) angiography using MDCT provides detailed information regarding the relation between bronchial artery ostia and tracheal bifurcation.

Peer review

This is a well-written manuscript that aim to explore the anatomical relationships between bronchial artery and tracheal bifurcation using CTA. There are a few points to be cleared.

REFERENCES

1 **Remy-Jardin M**, Bouaziz N, Dumont P, Brillet PY, Bruzzi J, Remy J. Bronchial and nonbronchial systemic arteries at multi-detector row CT angiography: comparison with conventional angiography. *Radiology* 2004; **233**: 741-749

2 **Bruzzi JF**, Rémy-Jardin M, Delhaye D, Teisseire A, Khalil C, Rémy J. Multi-detector row CT of hemoptysis. *Radiographics* 2006; **26**: 3-22

3 **Yoon YC**, Lee KS, Jeong YJ, Shin SW, Chung MJ, Kwon OJ. Hemoptysis: bronchial and nonbronchial systemic arteries at 16-detector row CT. *Radiology* 2005; **234**: 292-298

4 **Chung MJ**, Lee JH, Lee KS, Yoon YC, Kwon OJ, Kim TS. Bronchial and nonbronchial systemic arteries in patients with hemoptysis: depiction on MDCT angiography. *AJR Am J Roentgenol* 2006; **186**: 649-655

5 **Morita Y**, Takase K, Ichikawa H, Yamada T, Sato A, Higano S, Takahashi S. Bronchial artery anatomy: preoperative 3D simulation with multidetector CT. *Radiology* 2010; **255**: 934-943

6 **Battal B**, Saglam M, Ors F, Akgun V, Dakak M. Aberrant right bronchial artery originating from right coronary artery - MDCT angiography findings. *Br J Radiol* 2010; **83**: e101-e104

7 **Yoon W**, Kim JK, Kim YH, Chung TW, Kang HK. Bronchial and nonbronchial systemic artery embolization for life-threatening hemoptysis: a comprehensive review. *Radiographics* 2002; **22**: 1395-1409

8 **Yoon W**, Kim YH, Kim JK, Kim YC, Park JG, Kang HK. Massive hemoptysis: prediction of nonbronchial systemic arterial supply with chest CT. *Radiology* 2003; **227**: 232-238

9 **Rémy J**, Arnaud A, Fardou H, Giraud R, Voisin C. Treatment of hemoptysis by embolization of bronchial arteries. *Radiology* 1977; **122**: 33-37

10 **Kasai T**, Chiba S. Macroscopic anatomy of the bronchial arteries. *Anat Anz* 1979; **145**: 166-181

11 **Cauldwell EW**, Siekert RG. The bronchial arteries; an anatomic study of 150 human cadavers. *Surg Gynecol Obstet* 1948; **86**: 395-412

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