Left Main Bronchus as an Anatomical Landmark in Bronchial Angiography

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Rapid and accurate catheterization of bronchial artery is very important for emergent embolization treatment of massive hemoptysis. The origin of the bronchial artery is widely variable referred to the level of thoracic vertebrae, which makes it an unreliable localization reference. We, therefore, retrospectively analyzed the relationship between left main bronchus (LMB) and the origin of the left and right bronchial arteries in patients undergoing bronchial angiogram for life-threatening hemoptysis to determine whether the LMB can be as a radiographic landmark for catheterization of the bronchial artery.

From January 1994 to July 2002, there were consecutively 31 patients underwent emergent bronchial angiogram to manage the life-threatening hemoptysis. Their bronchial angiograms were retrospectively reviewed by two attending radiologists to identify the relationship of the translucent shadow of the LMB and the origins of right and left bronchial arteries respectively. The anatomical relationship of the origin of a specific bronchial artery to the LMB was defined as six levels: (1) above the upper margin of LMB and beyond one rib-width, (2) above the upper margin of LMB but not beyond one rib-width, (3) within the upper-half shadow of LMB, (4) within the lower-half shadow of LMB, (5) below the lower margin of LMB but not beyond one rib-width, (6) below the lower margin of LMB and beyond one rib-width.

There were totally 51 bronchial angiograms performed, including 27 right bronchial arteries and 24 left bronchial arteries. Most of the right bronchial arteries originated within the range between one-rib width above and below the LMB (level 2 to level 5), especially within the shadow of LMB (33.3% at level 3 and 22.2% at level 4). The origins of left bronchial arteries were more variable and about half of them originated above the LMB (20.8% at level 1 and 25.0% at level 2).

Our findings suggested that an efficient way to catheterize right bronchial arteries should begin within the range of LMB shadow (levels 3 and 4), then one-rib width above and below LMB (levels 2 and 5), and finally beyond one-rib range (levels 1 and 6). In contrast, a reasonable catheterization procedure of left bronchial arteries should be performed following a craniocaudal sequence, i.e. from level 1 downward to level 6.

Key words: Anatomy; Angiography; Bronchial artery; Bronchus

Rapid and accurate catheterization of bronchial arteries is very important for life-saving transarterial embolization during massive hemoptysis [1, 2, 5-12]. The level or range of the thoracic vertebrae is commonly used as a radiographic landmark for searching the origins of bronchial arteries during bronchial angiography [1, 2]. Unfortunately, there was a wide variation regarding the origins of bronchial arteries. As a result, it is not easy to identify their orifices from aorta based on the thoracic vertebrae levels under fluoroscopy [3]. Furthermore, the thoracic aortogram could not provide adequate information for the localization of the origins of bronchial arteries due to respiratory motion artifacts and poor opacification of the small bronchial arteries. The aims of this retrospective study were to analyze the anatomical relation between the left main bronchus (LMB) and the right and the left bronchial arteries, and to find an efficient
catheterization procedure for rapid and accurate identification of bronchial arteries during emergent angiography.

**MATERIALS AND METHODS**

During the period between January 1994 and July 2002, a total of 31 patients with life-threatening massive hemoptysis were referred for emergent bronchial angiography and transarterial embolization. There were 25 men and 6 women, with an age range from 14 to 87 years old (mean, 52.5 years). Emergent bronchial angiography was performed by catheterization of right or left bronchial artery with a 4-F or 5-F Mikaelsson catheter (Terumo, Tokyo, Japan) through a 5-F introducer in the right or left femoral artery. Bronchial angiogram was obtained with a total of 6 - 8 ml of contrast medium (Angiografin or Omnipaque) at an injection rate of 2 ml/sec, injection pressure of 300 psi and imaging rate of 3/sec.

Bronchial angiograms was retrospectively reviewed by two radiologists independently with the final decision reached by consensus. The angiograms were analyzed with regard to the relationship of the origins of bronchial arteries to the LMB. The LMB was recognized as a lucent tubular structure arising from the carina running inferolaterally into the mediastinum and crossing over the proximal descending aorta. The origins of bronchial arteries were recognized as the point of the contrast medium reflux into thoracic aorta during bronchial arterial injection (Fig. 1). The relationship of the origins of bronchial arteries to the LMB was categorized into one of the following six levels (Fig. 2): level 1 -- above the upper margin of LMB and beyond one rib-width; level 2 -- above the upper margin of LMB but not beyond one rib-width; level 3 -- within the upper-half shadow of LMB; level 4 -- within the lower-half shadow of LMB; level 5 -- below the lower margin of LMB but not beyond one rib-width; and level 6 -- below the lower margin of LMB and beyond one rib-width.

**RESULTS**

There were 51 bronchial angiograms performed in the 31 patients, including 27 right bronchial arteries and 24 left bronchial arteries. The causes of hemoptysis were tuberculosis (16 cases, 51.6%), bronchiectasis (7 cases, 22.5%), COPD (5 cases, 16.1%), and bronchogenic carcinoma (3 cases, 9.6%). The relationship of the origins of bronchial arteries and LMB is shown in Table 1. The origins of right bronchial arteries were most frequently within the LMB shadow, i.e. level 3 (33.3%) and level 4 (22.2%), and secondly within the range one-rib above (level 2, 18.5%) or below (level 5, 14.8%) LMB. There were only three out of the 27 (11.1%) right bronchial arteries originated from a level beyond one rib-width from the LMB (levels 1 and 6). The incidence of origins of left bronchial arteries was higher when above the LMB (levels 1 and 2, 45.8%), intermediate within the LMB shadow (levels 3 and 4, 29.1%), and lower when below the LMB (levels 5 and 6, 24.9%).

**DISCUSSION**

Transcatheter arterial embolization of the bronchial artery is considered to be an effective technique in the treatment of life-threatening massive hemoptysis [1, 2, 5-12]. The key point in successful embolization is rapid and accurate catheterization of the bronchial artery. Most of the conventional reference landmarks for determining the origins of bronchial arteries were focused on the level or range of the thoracic vertebrae [1, 2]. However, catheterization of bronchial arteries under fluoroscopic guide by

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**Table 1. The spatial relationship of the location of the origins of bronchial arteries to the left main bronchus in true frontal position**

<table>
<thead>
<tr>
<th>Side of bronchial artery</th>
<th>level 1</th>
<th>level 2</th>
<th>level 3</th>
<th>level 4</th>
<th>level 5</th>
<th>level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>right</td>
<td>1(3.7%)</td>
<td>5(18.5%)</td>
<td>9(33.3%)</td>
<td>6(22.2%)</td>
<td>4(14.8%)</td>
<td>2(7.4%)</td>
</tr>
<tr>
<td>left</td>
<td>5(20.8%)</td>
<td>6(25.0%)</td>
<td>3(12.5%)</td>
<td>4(16.6%)</td>
<td>4(16.6%)</td>
<td>2(8.3%)</td>
</tr>
</tbody>
</table>
using thoracic vertebrae as a reference landmark is always unreliable and time-consuming. Recently, Tanomkiat et al. used the catheter tip to define the origin of a specific bronchial artery and demonstrated that the LMB might be a reliable anatomical landmark for bronchial angiography [4]. However, because there is always a winding course of the proximal bronchial artery, the position of a catheter tip is not identical to the actual orifice of a bronchial artery from the thoracic aorta. Therefore, in the present study, the origin of a bronchial artery was localized to the point where contrast medium reflux occurred from a bronchial artery into the thoracic aorta.

On comparison with the thoracic vertebra behind the mediastinal soft tissue, it is always easier to recognize the radiolucent LMB and identify its common course crossing the proximal thoracic aorta on fluoroscopy, which is very helpful for quick anatomical localization when performing emergent bronchial angiogram. According to classification system in this study, the relationship of the origins of right bronchial arteries to the LMB was mostly at level 3 and 4, secondly at levels 2 and 5, and least at levels 1 and 6. These findings suggested that the most effective way to successfully catheterize a right bronchial artery should begin within the LMB shadow, then within one-rib width above and below, and finally beyond one-rib width. On the other hand, the distribution of the origins of left bronchial arteries was variable. The origins of left bronchial arteries were mostly at levels 1 and 2, and similarly among levels 3, 4 and 5, and least at level 6. A reasonable way, but not necessarily the most effective way, for left bronchial artery catheterization is a craniocaudal orientation from level 1 to level 6 accordingly.

Tanomkiat et al. have stated that more than 90% bronchial arteries arose from the level at or near the LMB [4]. Taken together the findings of right and left bronchial arteries in the present study, the origins of bronchial arteries were most frequently found at level 3 (12/51 = 23.5%), level 2 (11/51 = 21.6%), and level 4 (10/51 = 19.6%), consistent with the report of Tanomkiat et al. Furthermore, the present study showed that there seemed to be a different pattern of bronchial artery origin between right and left sides, which might be helpful for anatomical localization during bronchial angiography. Further studies in a large cohort of patients should solidify these preliminary results.

In conclusion, the origins of right bronchial arteries were most frequently within the radiolucent shadow of the LMB, while the origins of left bronchial arteries were mainly just above the LMB. These findings may be helpful in bronchial artery catheterization during emergent bronchial angiography.

REFERENCES


Figure 2. Schematic sketch of the six-level classification of the spatial relationship of the origins of bronchial arteries to the left main bronchus (1: level 1; 2: level 2; 3: level 3; 4: level 4; 5: level 5; 6: level 6; RMB: right main bronchus; LMB: left main bronchus; T: trachea; A: thoracic aorta).
左側主支氣管：一個支氣管動脈攝影術的解剖學參考指標

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對於大量咳血的病人，快速及正確的找到支氣管動脈源頭並予以栓塞是很重要的治療方法。由於支氣管動脈源頭有許多的變異性，所以傳統上以胸椎為支氣管動脈攝影的參考指標是不夠的。因此，我們回顧一些罹患致命性咳血病患的支氣管動脈攝影，分析左側主支氣管與左、右支氣管動脈源頭間的關係以了解左側主支氣管是否可供從事支氣管動脈攝影術的有用參考指標。

從1994年1月到2002年7月，共有31位病患因罹患致命性咳血而接受支氣管動脈攝影術。由兩位放射診斷專科醫師重新審視這些血管攝影片並訂出左側主支氣管與左、右支氣管源頭間的關係。我們將這兩者的關係分為6個levels：（1）源頭在左側主支氣管上緣超過一個肋骨寬度；（2）源頭在左側主支氣管上緣不超過一個肋骨寬度；（3）源頭在左側主支氣管上半部；（4）源頭在左側主支氣管下半部；（5）源頭在左側主支氣管下緣超過一個肋骨寬度；（6）源頭在左側主支氣管下緣超過一個肋骨寬度。

總共施行了51條支氣管動脈攝影，其中右支氣管動脈有27條，左支氣管動脈有24條。大部份右側支氣管動脈起源自於左側主支氣管及其上、下一個肋骨寬度的位置（level 2到level 5），尤其是在左側主支氣管源頭的位置（level 3：33.3%及level 4：22.2%）。至於左支氣管動脈的起源則有較多的變異性，大約有一半起源於左側主支氣管源頭上方的位置（level 1：20.8%及level 2：25.0%）。

我們分析的結果發現在從事右側支氣管動脈攝影時，最有效的方法是從左側主支氣管陰影的位置（level 3及level 4）去找支氣管動脈開口，之後再找左側主支氣管陰影上、下一個肋骨寬度（level 2及level 5）的位置，最後再找左側主支氣管陰影上、下超過一個肋骨寬度（level 1及level 6）的位置。相反的，在從事左側支氣管動脈攝影時則應由左側主支氣管陰影上方逐段找下來，即由level 1往level 6找是比較好的一種方法。

關鍵詞：解剖學，血管攝影，支氣管動脈，支氣管