

# Visualization of the Origin of the Vertebral Arteries with Color Doppler Sonography

— 색도플러 초음파검사에 의한 경추골동맥 기시부 관찰 —

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— Abstract —

**Background/aim** : Atherosclerotic disease at the origin of the vertebral arteries is one of the risk factors for vertebrobasilar ischemic disease. Assessment and visualization of the origin of the vertebral arteries with color doppler sonography is a non-trivial task. The aim of this study is to increase the visualization rate of the origin of the vertebral arteries with color doppler sonography.

**Materials and Methods** : Color doppler sonography for the vertebral arteries included carotid arteries was performed to 198 patients. We first examined the vertebral artery in the upper neck in the direction of the subclavian artery to distinguish its origin more easily. If the vertebral artery origin was not visualized in natural position, the examiner pushed the transducer toward a clavicle or pushed the shoulder of patient by the other hand. The technical methods for visualization of the vertebral artery origin were classified into three grades: natural position, pushing the transducer, and pushing the shoulder of patient according to the depth (3.0 cm and shallower, deeper than 3.0 cm) of the origin.

**Results** : The origin of the vertebral arteries could be visualized in 97% on the right and in 92% on the left. The origin of the vertebral arteries could be visualized in 98.6%, 1.4%, and 0.0% in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at shallower than 3.0 cm on the right side. The origin of the vertebral arteries could be visualized in 81.2%, 14.6%, and 4.2% in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at deeper than 3.0 cm on the right side. The origin of the vertebral arteries could be visualized in 85.4%, 10.7%, and 3.9% in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at shallower than 3.0 cm on the left side. The origin of the vertebral arteries could be visualized in 55.7%, 30.4%, and 13.9% in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at deeper than 3.0 cm on the left side.

**Conclusion** : If the examiner pushes the transducer toward a clavicle or pushes the shoulder of patient by the other hand, when the vertebral artery origin during the color doppler sonography is not visualized in natural position, visualization rate of the origin of the both vertebral arteries is increased.

**Key Words** : Origin, Vertebral artery, Color doppler sonography

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## I. Introduction

The vertebral arteries play a significant role in the blood supply to the brain. Atherosclerotic disease at the origin of the vertebral arteries is one of the risk factors for vertebrobasilar ischemic disease<sup>1)</sup>. Therefore this is needed to evaluate pathologic findings. Continuous-wave doppler sonography has been the first noninvasive technique for assessment of the pathologic findings such as stenosis, hypoplasia, and occlusion of the extracranial vertebral arteries<sup>2-4)</sup>. This method also is very convenient in the diagnosis of the subclavian steal syndrome from evidence of reversed flow in the vertebral artery due to stenosis or occlusion of the subclavian artery<sup>5)</sup>. Assessment and visualization of the origin of the vertebral arteries with this method is difficult technically, especially the left. The technical quality of visualization of the origin of the vertebral arteries is greatly influenced by the localization and anatomic variations of the examined structure<sup>6,7)</sup>. The visualization of the origin of the vertebral artery varies from 81% to 94% on the right side and 60% to 86% on the left side in the different studies, the right side being visualized more frequently than the left<sup>1,4,7,8)</sup>.

The aim of this study is to increase the visualization rate of the origin of the vertebral arteries with color doppler sonography.

## II. Materials and Methods

Color doppler sonography for the vertebral arteries included carotid arteries was performed on 198 patients at our clinical ultrasound laboratory from April to August 2008.

The patients were 130 men and 68 women, and the mean age was 62.4 years (ranged 22 to 88). Ultrasound examinations were carried out by a iu 22 (Philips Ultrasound, USA) duplex scanner with a 3 and 9 MHz linear array transducer. Duration of the examination was 20 to 30 minutes.

The patient was examined in supine position with the head rotated away from the side being studied, to exposed the lateral side of the neck. The origin of the vertebral arteries was distinguished from other arterial vessel and the vertebral vein by its pulsatility and the evidence of the typical doppler signal in the vessel (Fig. 1).

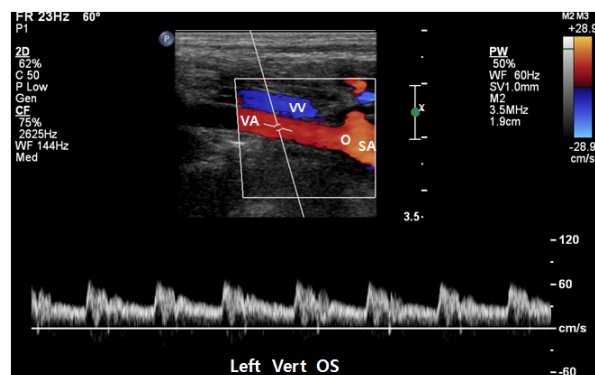


Fig. 1. View of the vertebral artery origin. The origin can be distinguished from other arterial vessel and the vertebral vein by its low resistance flow characteristics

VA : vertebral artery, O : origin, SA : subclavian artery, VV : vertebral vein

We also first examined the vertebral artery in the upper neck in the direction of the subclavian artery so as to distinguish its origin more easily. If the origin of the vertebral arteries was not visualized in natural position, the examiner pushed the transducer toward a clavicle, and not yet visualized, pushed the shoulder of patient by the other hand. Therefore, the technical methods for visualization of the origin of the vertebral arteries were classified into the plan of three grade included natural position, pushing the transducer, and pushing the shoulder of patient according to the depth (3.0 cm and shallower, deeper than 3.0 cm) of the origin located on sonogram. We also assessed the pathologic findings such as stenosis, hypoplasia, and occlusion of the origin of the vertebral arteries on our sonograms.

### III. Results

The origin of the vertebral arteries could be visualized in 97% (192/198) on the right side and in 92% (182/198) on the left side (Table 1).

**Table 1.** Visualization of the vertebral artery origin

Region	Rt vertebral artery (n=198)	Lt vertebral artery (n=198)
Origin	97% (192)	92% (182)

#### 1. Pathologic findings

The stenosis with more than 50% (diameter criteria) of the origin of the vertebral artery was present in 6.1% (12/198) on the right side and in 3.0% (6/198) on the left side, the vertebral artery hypoplasia was present in 2.5% (5/198) on the right side and in 8.6% (17/198) on the left side, and occlusion was present in 2.0% (4/198) on the right side and in 1.0% (2/198) on the left side (Table 2).

**Table 2.** The abnormal pathologic findings of the vertebral arteries or its origin

Pathologic findings	Rt vertebral artery (n=198)	Lt vertebral artery (n=198)	Total (n=198)
Stenosis*	6.1% (12)	3.0% (6)	9.1% (18)
Hypoplasia	2.5% (5)	8.6% (17)	11.1% (22)
Occlusion	2.0% (4)	1.0% (2)	3.0% (6)

\* Stenosis with more than 50% of origin

#### 2. Technical methods

In the technical methods including natural position, pushing the transducer, and pushing the shoulder of patient for visualization of the origin of the vertebral arteries according to the depth of that located on sonogram.

The mean depth of vertebral arteries located on sonogram in our study was 3.0 cm (ranged 2.0 to 5.5). The origin of the vertebral artery could be visualized in 98.6% (142/144), 1.4% (2/144), and 0.0% (0/144) in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at 3.0cm and shallower on the right side. The origin of the vertebral artery could be visualized in 81.2% (39/48), 14.6% (7/48), and 4.2% (2/48) in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at deeper than 3.0cm on the right side (Table 3).

The origin of the vertebral artery could be visualized in 85.4% (88/103), 10.7% (11/103), and 3.9% (4/103) in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at 3.0 cm and shallower on the left side. The origin of the vertebral artery could be visualized in 55.7% (44/79), 30.4% (24/79), and 13.9% (11/79) in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at deeper than 3.0cm on the left side (Table 4).

**Table 3.** The visualization of the vertebral artery origin according to the technical methods and depth of that located on the right side

Depth	Natural position	Pushing transducer	Pushing shoulder	Total
≤ 3,0 cm	98.6% (n=142/144)	1.4% (n=2/144)	0.0% (n=0/144)	75.0% (n=144/192)
> 3,0 cm	81.2% (n=39/48)	14.6% (n=7/48)	4.2% (n=2/48)	25.0% (n=48/192)
Total	94.3% (n=181/192)	4.7% (n=9/192)	1.0% (n=2/192)	100% (n=192/192)

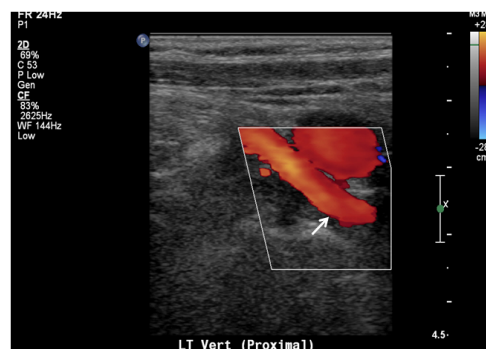
**Table 4.** The visualization of the vertebral artery origin according to the technical methods and depth of that located on the left side

Depth	Natural position	Pushing transducer	Pushing shoulder	Total
≤ 3.0 cm	85.4% (n=88/103)	10.7% (n=11/103)	3.9% (n=4/103)	56.6% (n=103/182)
> 3.0 cm	55.7% (n=44/79)	30.4% (n=24/79)	13.9% (n=11/79)	43.4% (n=79/182)
Total	72.5% (n=132/182)	19.2% (n=35/182)	8.3% (n=15/182)	100% (n=182/182)

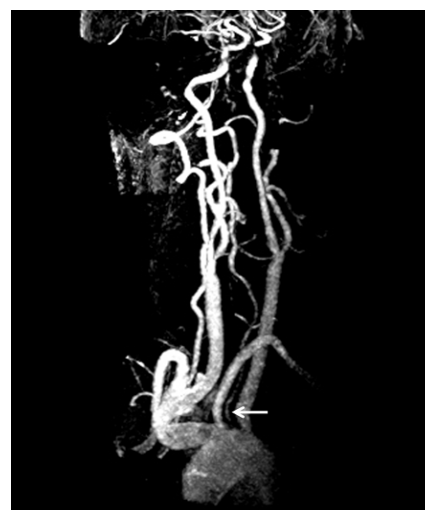
#### IV. Discussion

Atherosclerotic disease at the origin of the vertebral arteries is one of the risk factors for vertebrobasilar ischemic disease, and the significant stenosis occurs mainly in this origin of the vertebral arteries<sup>9-11)</sup>. Therefore, visualization of the origin of the vertebral arteries is necessary to identify such lesions.

Only a few studies have revealed data about the origin of the vertebral arteries with color doppler sonography, since by Touboul PJ et al.<sup>7)</sup>. The visualization rate of the origin of the vertebral artery varies from 81% to 94% on the right side and 60% to 86% on the left side in the different studies, the right side being visualized more frequently than the left<sup>1,4,7,8)</sup>. The percentage of the origin of the vertebral arteries with color doppler sonography reported by other authors was similar. In our study, the origin of the vertebral artery could be visualized in 97% (n=192/198) on the right side and in 92% (n=182/198) on the left side (Table 1). All these studies demonstrated that visualization of the origin of the vertebral artery is easier on the right side than on the left. This difference might be explained by localization deeper and more medially than that of the right, and anatomic variations, with the left vertebral artery arising directly from the aortic arch (in 8% by Korbicka J et al.<sup>12)</sup>, 5.8% by Yamaki KI et al.<sup>6)</sup>). In our study, the origin of the left vertebral artery arising directly from the aortic arch was present assumptively in 3.6% (n=7/192) which was visualized a proximal portion only (Fig. 2).



(a)

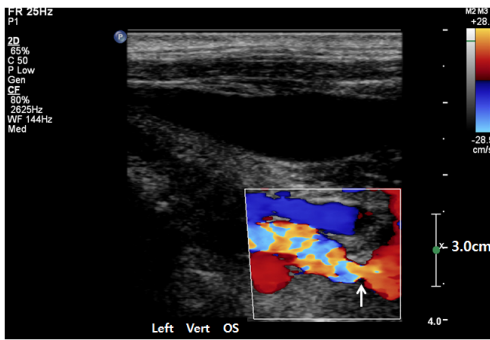


(b)

**Fig. 2.** The proximal portion of the vertebral artery from the subclavian artery on the left side (a), and its MR image (b). The vertebral artery origin is arising directly from the aortic arch (b)

The significant stenosis occurs mainly in this origin of the vertebral arteries, and it is one of the risk factors for vertebrobasilar ischemic disease. Therefore, visualization of the origin of the vertebral arteries is necessary to identify such lesions.

In our study, The stenosis with more than 50% (diameter criteria) of the origin of the vertebral arteries was present in 9.1% (n=18/198) (Fig. 3). This data might be demonstrated that visualization of the origin of the vertebral arteries is necessary. The vertebral artery hypoplasia was present in 11.1% (n=22/198), and this percentage was slightly higher than 6.0% (n=3/50) by Touboul PJ et al.<sup>7)</sup>. Occlusion was also present in 3.0% (n=6/198) in our study (Table 2).



**Fig. 3.** Stenosis with more than 50% of the left vertebral artery origin. The origin was located at deeper than 3.0 cm on sonogram, and it could be visualized by pushing the transducer toward a clavicle

Assessment and visualization of the origin of the vertebral arteries with color doppler sonography is difficult technically, especially the left. The relatively low rate of visualization of the origin of the left vertebral artery might be due to localization deeper and more medially than that of the right, and arising directly from the aortic arch (in 8% by Korbicka J et al.<sup>12)</sup>, 5.8% by Yamaki KI et al.<sup>6)</sup> which is extremely rare on the right.

The visualization rate of the origin of the vertebral artery varies from 81% to 94% on the right side and 60% to 86% on the left side in the different studies, the right side being visualized more frequently than the left<sup>1,4,7,8)</sup>. In our study, the origin of the vertebral artery could be visualized in 97% (n=192/198) on the right side and in 92% (n=182/198) on the left side.

Visualization rate of the origins of the both vertebral arteries was higher than the other reports. This result may be in our technical methods. We first examined the vertebral artery in the upper neck in the direction of the subclavian artery so as to distinguish its origin more easily. If the origin of the vertebral arteries was not visualized in natural position, the examiner pushed the transducer toward a clavicle, and not yet visualized, pushed the shoulder of patient by the other hand.

In anatomical depth, 75.0% (n=144/192) was in 3.0 cm and shallower and 25.0% (n=48/192) was in deeper than 3.0 cm on the right side (Table 3). 56.6% (n=103/182) was in 3.0 cm and shallower and 43.4% (n=79/182) was in deeper than 3.0 cm on the left side (Table 4). The relatively depth of the origin of the left was deeper than that of the right, so visualization of the origin of the left vertebral arteries was difficult technically (Fig. 3). The origin of the vertebral artery could be visualized in 81.2% (39/48), 14.6% (7/48), and 4.2% (2/48) in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at deeper than 3.0 cm on the right side (Table 3). Whereas the origin of the vertebral artery could be visualized in 55.7% (44/79), 30.4% (24/79), and 13.9% (11/79) in natural position, pushing the transducer, and pushing the shoulder of patient, respectively, at deeper than 3.0 cm on the left side (Table 4).

## V. Conclusion

Assessment and visualization of the origin of the vertebral arteries with color doppler sonography is difficult technically, especially the left. The relatively low rate of visualization of the origin of the left vertebral artery might be due to localization deeper and more medially than that of the right, and arising directly from the aortic arch. If the examiner pushes the transducer toward a clavicle or pushes the shoulder of patient by the other hand,

when the vertebral artery origin is not visualized in natural position, visualization rate of the origin of the both vertebral arteries is increased.

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## 색도플러 초음파검사에 의한 경추골동맥 기시부 관찰

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**배경/목적** : 경추골동맥 기시부의 동맥경화증은 경추기저 국소빈혈증의 위험인자 중 하나이기 때문에 경추골동맥 기시부를 확인해야 할 필요가 있다. 색도플러 초음파검사에 의한 경추골동맥 기시부의 관찰 및 평가는 기술적으로 어려움이 있으며, 특히 왼쪽 기시부는 더욱 그렇다. 이 연구의 목적은 색도플러 초음파검사 시 경추골동맥 기시부의 관찰률을 높이는 것이다.

**대상 및 방법** : 경동맥을 포함한 경추골동맥의 색도플러 초음파검사가 198명에 대해 시행되었다. 경추골동맥 기시부를 다른 혈관의 기시부와 더 쉽게 구분하기 위해 목 윗부분의 경추동맥에서부터 쇄골하동맥 측으로 검사를 시행하였다. 검사 기술적으로 경추골동맥 기시부가 바로누운자세의 자연스러운 위치에서 관찰되지 않을 경우, 초음파 트랜스듀서를 쇄골 측으로 밀고, 그래도 관찰되지 않을 경우 다른 손으로 어깨를 밀어 관찰을 시도하였다. 경추골동맥 기시부의 깊이와 위 세 가지 방법 및 그에 따른 관찰률을 확인하기 위하여, 검사된 초음파 영상에서 관찰된 경추골동맥 기시부의 위치를 3.0 cm 이하와 그 이상으로 구분하였다.

**결 과** : 오른쪽 경추골동맥 기시부는 97%, 왼쪽 경추골동맥 기시부는 92%에서 관찰되었다. 3.0 cm 이하에서 관찰된 오른쪽 경추골동맥 기시부 중 자연스러운 자세, 트랜스듀서 밀기, 그리고 어깨 밀기에서 관찰된 경우는 각각 98.6%, 1.4%, 그리고 0.0%이었다. 그리고 3.0 cm 보다 더 깊은 위치에서 관찰된 오른쪽 경추골동맥 기시부 중 자연스러운 자세, 트랜스듀서 밀기, 그리고 어깨 밀기에서 관찰된 경우는 각각 81.2%, 14.6%, 그리고 4.2%이었다. 3.0 cm 이하에서 관찰된 왼쪽쪽 경추골동맥 기시부 중 자연스러운 자세, 트랜스듀서 밀기, 그리고 어깨 밀기에서 관찰된 경우는 각각 85.4%, 10.7%, 그리고 3.9%이었다. 그리고 3.0 cm 보다 더 깊은 위치에서 관찰된 오른쪽 경추골동맥 기시부 중 자연스러운 자세, 트랜스듀서 밀기, 그리고 어깨 밀기에서 관찰된 경우는 각각 55.7%, 30.4%, 그리고 13.9%이었다.

**결 론** : 경추골동맥의 색도플러 초음파검사에서 그 기시부가 바로누운자세의 자연스러운 위치에서 관찰되지 않을 경우, 초음파 트랜스듀서를 쇄골 측으로 밀거나 그래도 관찰되지 않을 경우 다른 손으로 어깨를 밀어 관찰을 시도한다면, 관찰률을 좀더 높일 수 있을 것으로 사료된다.

**중심 단어**: 기시부, 경추골동맥, 색도플러 초음파검사

