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# Pitfall of vertebral artery insonation: Bidirectional flow without subclavian artery pathology

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## KEYWORDS

Vertebral artery;  
Pitfall;  
Alternating flow;  
Bidirectional flow;  
Duplex sonography;  
Subclavian steal  
syndrom

## Summary

**Background:** A bidirectional flow pattern within the intracranial segment of the vertebral artery (V4–VA) should be indicative of a proximal steno-occlusive disorder of the ipsilateral subclavian artery (SA). Here we present two patients revealing this ultrasound finding without evidence of a specific SA pathology.

**Methods/case reports:** In case 1 duplex sonography revealed a diameter of the left V2–VA of 3.3 mm and 2.7 mm on the right side. Normal flow signals were detected in the left V2–VA, a systolic flow deceleration was seen on the right side. Intracranially, a biphasic flow pattern was observed in the right V4–VA. The left V4–VA, the basilar artery and the brachial arteries (BrA) as well as the cuff-test were normal. Conventional angiography ruled out a SA or VA pathology. A bilateral fetal-type posterior cerebral artery (FT-PCA) was seen. CT angiography demonstrated a small diameter of the right intracranial V4–VA close to the basilar confluens.

In case 2 VA diameter of the left and right V2–VA was 3.3 and 2.3 mm, respectively. Flow signals, similar to case 1 were observed in the non-dominant V2–VA and V4–VA segment. The remaining vessels and the cuff-test were normal. MR angiography demonstrated a FT-PCA and an incomplete posterior inferior cerebellar artery (PICA)-ending VA on the right side.

**Conclusions:** A bidirectional flow in V4–VA can not prove a subclavian steal phenomenon. A normal triphasic flow signal of the brachial artery excludes a relevant proximal obstruction of the SA. Also, diameter measurements of the VA are mandatory.

It seems that physiological variants of the vertebrobasilar circulation like a VA hypoplasia, PICA-ending VA or FT-PCA might also cause the above type of VA flow pattern.

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## Introduction

A bidirectional flow pattern within the intracranial segment of the vertebral artery (V4–VA) normally indicates a proximal steno-occlusive disorder of the ipsilateral subclavian artery. Depending on the grade of the SA stenosis a reduced systolic flow (systolic deceleration) may be observed within

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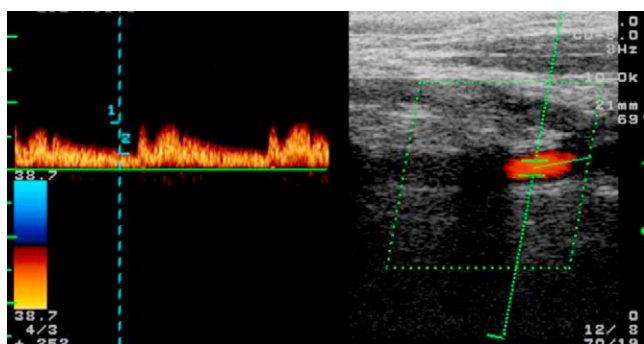


Figure 1 Right V2–VA with assumed systolic deceleration.

the ipsilateral VA in grade 1, an alternating flow in grade 2 or even a retrograde flow in grade 3 (Fig. S1). Indirect hemodynamic signs of obstruction of the SA can be seen in the distal depending vessels, e.g. in the ipsilateral brachial artery. In this case an attenuated flow pattern usually with a bi- or monophasic flow signal instead of the typical triphasic flow profile will be observed.

Here we present two patients revealing an alternating flow pattern in the intracranial segment of a vertebral artery without indication of subclavian artery pathology. There was also no evidence for a stenooclusive disorder in the ipsilateral brachiocephalic trunc or the proximal segment of the vertebral artery.

### Case reports

#### Case 1

A 69-year-old man was admitted after an episode of severe headache. Duplex sonography revealed mild atherosclerotic plaques. V2–VA diameter was 3.3 mm on the left, 2.7 mm on the right side. Normal flow signals were detected in the left V2–VA (Fig. S2), a flow pattern considered as a systolic flow deceleration was seen on the right side (Fig. 1). Intracranially, a biphasic flow pattern was observed in the right V4–VA distal the posterior inferior cerebellar artery (PICA) (Fig. 2). A normal flow pattern was seen in the right V4–VA proximal PICA (Fig. 3). The left V4–VA, the basilar artery and the brachial arteries (BrA) as well as the cuff-test were normal. Conventional angiography ruled out a SA or VA pathology (Fig. 4). A bilateral fetal-type posterior cerebral

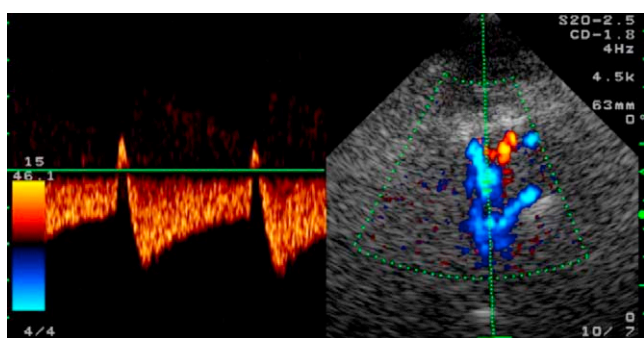


Figure 2 Right V4–VA distal PICA with bidirectional flow pattern.

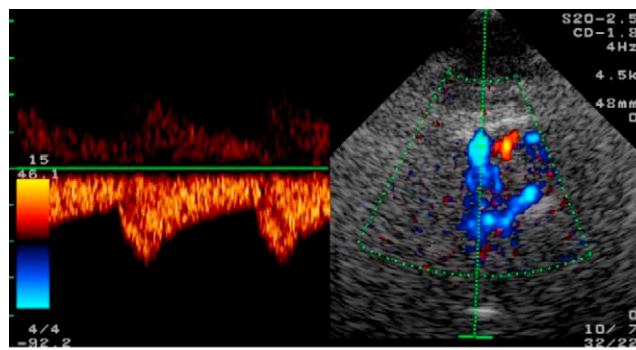


Figure 3 Right V4–VA proximal PICA with normal flow pattern.



Figure 4 Conventional angiography without SA stenosis.

artery (FT-PCA) was seen (Fig. 5). CT angiography demonstrated a small diameter of the right intracranial V4–VA close to the basilar confluens.

#### Case 2

This 79-year-old lady was seen after carotid surgery of a symptomatic right-sided internal carotid artery stenosis. Duplexsonography revealed a moderate left ICA stenosis. V2–VA diameter measurement showed a hypoplasia of the right side (2.3 mm) and a normal caliber on the left side (3.3 mm). Flow signals, similar to case 1 were observed in the non-dominant right V2–VA (Fig. 6) and V4–VA (Fig. S3). The brachial arteries (Fig. S4), the left-sided

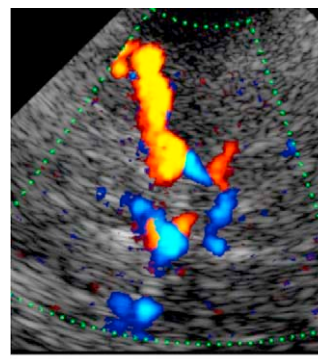
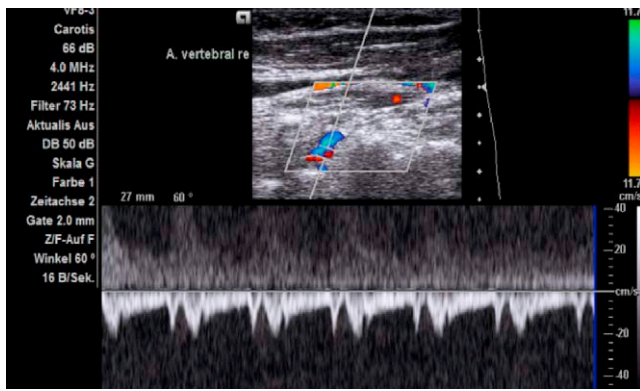


Figure 5 Circle of Willis with bilateral fetal type PCA.



**Figure 6** Right V2–VA with assumed systolic deceleration.

V2–VA (Fig. S5), and the cuff-test were normal. MR angiography demonstrated a FT-PCA and an incomplete posterior inferior cerebellar artery (PICA)-ending VA on the right side.

## Results

In these two cases we saw a bidirectional flow pattern in the intracranial V3- and/or V4-segment of the vertebral artery. In both cases a systolic deceleration was seen in the V2-segment of the ipsilateral vertebral artery. None of them had an obstruction of the subclavian artery, the brachiocephalic trunc or the proximal vertebral artery. In both cases we found variations of the vertebrobasilar circulation with a bilateral incomplete fetal type PCA, a PICA-ending vertebral artery and a hypoplasia of the ipsilateral vertebral artery.

## Discussion

In both cases we assumed that the bidirectional flow in the V4-segment of the vertebral artery might derive from the

V4-segment distal of the PICA origin. In such condition the main blood flow from the right vertebral artery takes the way through the right posterior inferior cerebellar artery. In case 1 this was seen in CT angiography, in case 2 in MR angiography. Due to a lower blood stream with less pressure for the flow through the very thin ipsilateral V4-segment and the normal flow in the contralateral vertebral artery this bidirectional flow pattern may arise. The situation may be intensified by difficult outflow conditions via the basilar artery and the incomplete fetal type of the posterior cerebral arteries.

## Conclusion

A bidirectional flow in the V4-segment of the vertebral artery cannot prove a subclavian steal syndrome. It may occur in normal subjects without evidence for an obstruction of the brachiocephalic trunc or of the ipsilateral proximal vertebral artery. To avoid such a pitfall the flow pattern of the brachial artery should be part of the examination. A normal triphasic flow pattern excludes a relevant obstruction of the proximal subclavian artery. Also diameter measurements of the VA are mandatory. It seems that variations of the vertebrobasilar circulation like PICA-ending vertebral artery, hypoplasia of the vertebral artery and fetal-type PCA might also cause a biphasic intracranial flow pattern. Regional different pressure ratios which are caused by individual in- and outflow conditions might be a main cause. Larger series are required to confirm these preliminary observations.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.permed.2012.04.003>.