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Case Report

A Rare Cause of Difficult Catheterization to the Left Brachiocephalic Vein during Transfemoral Transvenous Embolization

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Objective: We experienced a case of difficult catheterization to the left brachiocephalic vein (LBCV) during transfemoral transvenous embolization for traumatic carotid-cavernous fistula. We discussed the cause of this phenomenon.

Case Presentation: A 78-year-old woman with a traumatic carotid-cavernous fistula was treated with combined transarterial and transvenous embolization; however, catheterization to the LBCV was very difficult. A balloon guiding catheter (BGC) already placed in the left common carotid artery (LCCA) caused displacement of the LCCA and further compression of the originally stenotic LBCV.

A CT investigation of 104 cases of neuroendovascular treatment in our hospital revealed that the distance between the ventral bones and the dorsal arteries sandwiching the LBCV was significantly negatively correlated with age ($r = -0.41$, $p = 0.000020$). Aging and arteriosclerotic change are possibly related to the LBCV stenosis.

Conclusion: When catheterization to the LBCV is difficult during transfemoral transvenous embolization, not only the presence of anatomical variations and stenosis or occlusion of LBCV itself but also compression from surrounding structures should be considered, especially in elderly patients. In rare cases, a catheter inserted in an adjacent artery may cause further compression of the LBCV.

Keywords ▶ left brachiocephalic vein, transvenous embolization, venous compression

Introduction

Catheterization to the left brachiocephalic vein (LBCV) can sometimes be difficult during transfemoral transvenous embolization. This may be caused by the presence of anatomical variations,[1)] venous stenosis or occlusion,[2,3)] and changes in venous diameter due to respiration and body position.[4)] During a combined transarterial and transvenous embolization for a traumatic carotid-cavernous fistula, we experienced a phenomenon that displacement of the left common carotid artery (LCCA) due to insertion of a balloon guiding catheter (BGC) into the LCCA caused further compression of the originally stenotic LBCV, making it difficult to advance the catheter into the LBCV. We herein report this cause with anatomical considerations.

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Case Report

A combined transarterial and transvenous embolization for traumatic carotid-cavernous fistula (**Fig. 1**) was performed on a 78-year-old woman who presented a left temporal subcortical hemorrhage. Under general anesthesia, a 9 Fr BGC (Optimo, Tokai Medical Products, Aichi, Japan) was advanced to the left internal carotid artery via the right femoral artery. A BGC was used to perform a transarterial embolization of the lesion while controlling high flow shunt. Next, a 6 Fr guiding catheter (Roadmaster, Goodman, Aichi, Japan) was advanced to the superior vena cava via the right femoral vein. Then, to place the guiding catheter in the left internal jugular vein, we tried to advance the guidewire and the catheter to the LBCV; however, we could never advance them to the LBCV. We changed the coaxial catheter to a differently shaped one and even considered the presence of venous

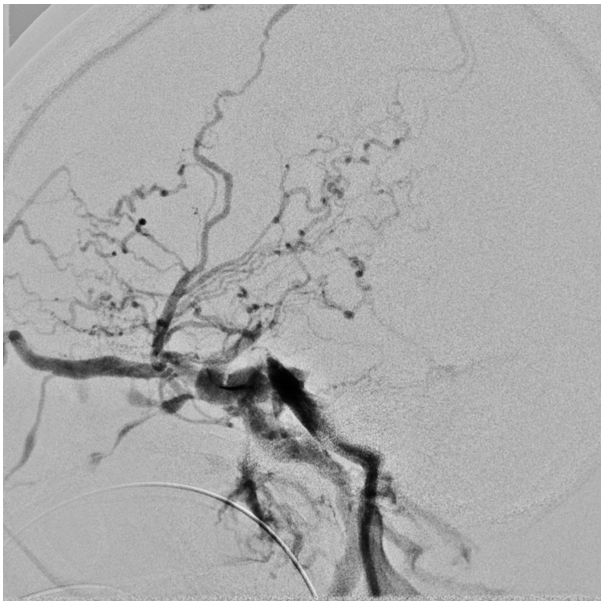

Fig. 1 Angiography of the left internal carotid artery shows carotid-cavernous fistula with remarkable cortical venous drainage.

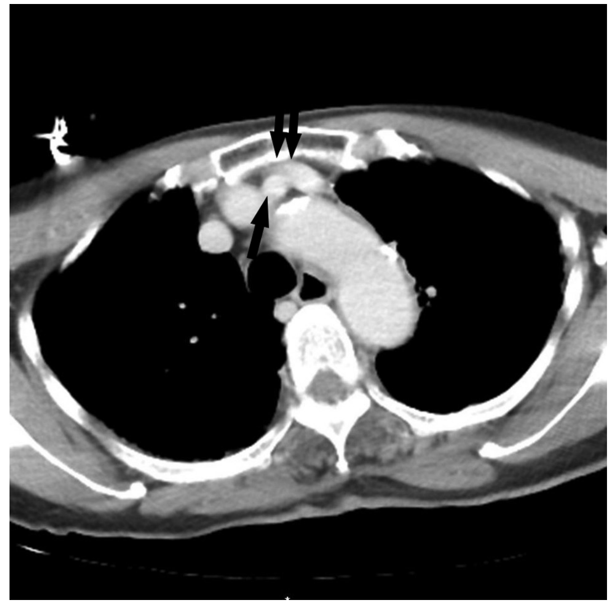

Fig. 3 Axial image of contrast-enhanced thoracic CT. The LBCV (double arrow) runs through the narrow space between the sternum and the LCCA (single arrow). LBCV: left brachiocephalic vein; LCCA: left common carotid artery

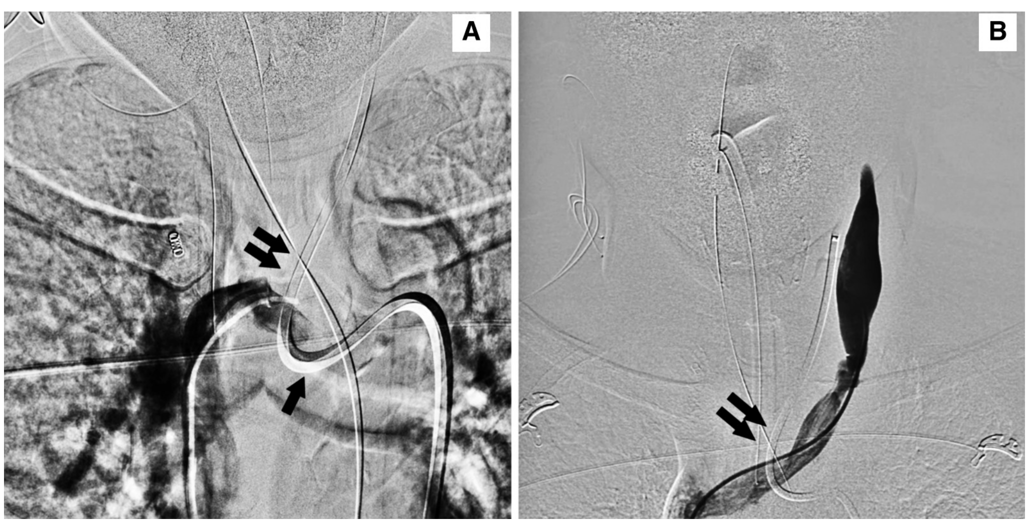

Fig. 2 (**A**) Venography from the superior vena cava. Reflux to the LBCV appears to be compressed and obstructed (double arrow) with the BGC (single arrow) in the LCCA. (**B**) Venography after the successful catheterization into the left internal jugular vein. The course of BGC in the LCCA was slightly straightened by pulling back the catheter and the compression of the LBCV was relieved (double arrow). BGC: balloon guiding catheter; LBCV: left brachiocephalic vein; LCCA: left common carotid artery

valves and anatomical variation such as the persistent left superior vena cava; however, we could not even advance the guidewire to the LBCV. Venography around from the superior vena cava demonstrated that the LBCV appeared to be compressed and be obstructed at the BGC in the LCCA (**Fig. 2A**). We speculated that the BGC in the LCCA would displace the LCCA itself and it might compress the LBCV. When the BGC was pulled back slightly, compression on the LBCV was relieved and we could smoothly advance the guidewire and the catheter into the LIJV from the LBCV without any difficulty (**Fig. 2B**). We have wasted about 40 minutes on this procedure. After that, the coils were inserted into the cavernous sinus both from transarterial and transvenous routes, and the shunt was completely occluded.

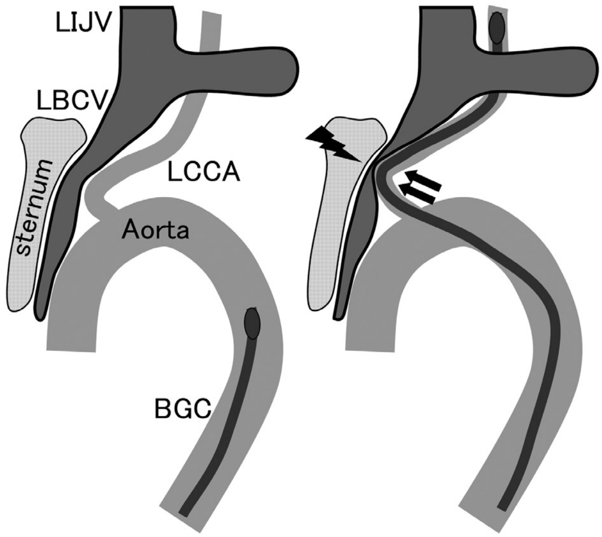

Fig. 4 Schematic illustration of this phenomenon. Originally stenotic LBCV, between the sternum and the tortuous LCCA, was further compressed by the BGC in the LCCA (double arrow). This disturbed the catheterization to the LBCV, furthermore to the LIJV. BGC: balloon guiding catheter; LBCV: left brachiocephalic vein; LCCA: left common carotid artery; LIJV: left internal jugular vein

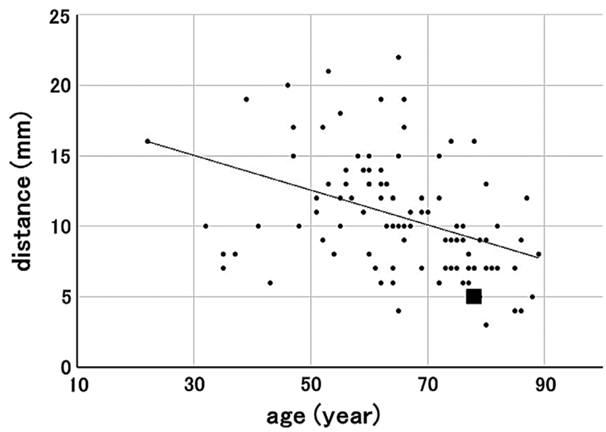

Fig. 5 Relation between age and the minimum bone–artery distance. There was a moderate negative correlation between age (65.1 + 13.4 years) and bone–artery distance (10.7 + 4.1 mm), r = –0.41, p = 0.000020, N = 104. Large square shows the present case.

Reviewing the CT angiography of this patient, it turned out that the LCCA had a tortuous course originating ventrally from the aortic arch, and the LBCV passed through a narrow space between the sternum and the tortuous LCCA (**Fig. 3**). We concluded that the hard and thick BGC in the LCCA displaced the LCCA itself, which caused further compression of the originally stenotic LBCV (**Fig. 4**).

Discussion

The LBCV runs through a narrow space between the ventral bone structures (the sternum and the left extremitas sternalis claviculae) and the dorsal arteries (the aortic arch, the brachiocephalic artery, the LCCA, and the left subclavian artery). Therefore, the LBCV is known as one of the common sites of central venous stenosis or occlusion.[5–7] Not only these anatomical characteristics but also aging and pathological changes in surrounding structures such as the aortic arch aneurysm can also cause the LBCV compression. Mitsuoka et al.[8] reported that the distance between the ventral bone and the dorsal brachiocephalic artery sandwiching the LBCV shortened with age. They speculated that compression of the LBCV may have been caused by the tortuous artery running behind the LBCV and the deformity of the thorax due to aging.

In the patients who have received neuroendovascular treatment in the last 2 years at our hospital and have been taken contrast-enhanced CT of whole body for preoperative access route assessment, the minimum distance (MD) between the ventral bone and the dorsal artery sandwiching the LBCV was measured on chest CT axial images and the relationship between the age and MD was examined.

A total of 104 patients including 56 men and 48 women (mean age 65.1 + 13.4 years) were retrospectively reviewed. As for the elements that comprised MD, sternum/brachiocephalic artery were the most common in 66 patients (63.5%), sternum/LCCA in 14 patients (13.5%), and left extremitas sternalis claviculae/LCCA in 10 patients (9.6%), sternum/aortic arch in 10 patients (9.6%), and left extremitas sternalis claviculae/left subclavian artery in 4 patients (3.8%). The mean length of MD was 10.7 + 4.1 mm. The correlation coefficient (r) and p value for age and MD were r = –0.41, p = 0.000020, indicating a moderate negative correlation (**Fig. 5**). In the presented patient, the LCCA was originating ventrally from the aortic arch and was running tortuously due to arteriosclerosis. The MD between the sternum and the tortuous LCCA sandwiching the LBCV was as narrow as 5 mm. Moreover, the displacement of the LCCA due to placement of the hard and thick BGC in the LCCA caused further compression of the originally stenotic LBCV. As expected, catheterization to the LBCV was easily achieved once the catheter in the LCCA was pulled back.

Thoracic wall movements by respiration and body position should also be considered as another cause of the

LBCV compression. Mori et al.[4] reported that elevation of the thorax during deep inspiration and the use of shoulder pillows can relieve compression on the LBCV. Our patient was not using shoulder pillows and was in a normal supine position under general anesthesia with a ventilator. Forced breath-holding after deep inspiration and usage of a shoulder pillows may have relieved the compression of the LBCV and have allowed passage of the guidewire or the catheter to the LBCV, even with the BGC in the LCCA.

When it is difficult to advance a guidewire or a catheter to the LBCV during transvenous embolization, not only the presence of anatomical variations and stenosis or occlusion of LBCV itself but also compression from surrounding structures should be considered, especially in elderly patients. Neuroendovascular surgeons should also be aware that in rare cases, LBCV compression can be caused by the insertion of a guiding catheter in an adjacent artery. In these situations, by removing or pulling back a catheter temporarily or using a smaller diameter catheter, the compression on the LBCV could be released.

Conclusion

When catheterization to the LBCV is difficult during transfemoral transvenous embolization, not only the presence of anatomical variations and stenosis or occlusion of LBCV but also compression from surrounding structures should be considered. In rare cases, a catheter inserted in an adjacent artery may cause further compression of the LBCV.

Disclosure Statement

There is no conflict of interest for the first author and coauthors.

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