

## Endovascular aortic repair with periscope graft technique in traumatic aortic transection

*Travmatik aortik transeksiyonda periskop greft tekniği ile endovasküler aortik tamir*

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### ABSTRACT

Aortic transections are the most fatal aortic injuries that may result from blunt thoracic trauma. Currently, endovascular aortic repair is the preferred treatment modality with low morbidity and mortality rates. Coverage of the left subclavian artery may be necessary to provide a safe landing zone. In such a situation, left subclavian artery flow may be preserved by chimney or periscope techniques. In this article, we report a 43-year-old female patient with acute aortic transection treated by endovascular aortic repair in which periscope graft was used for the left subclavian artery flow endurance.

**Keywords:** Aortic transection; chimney graft; endovascular treatment; periscope graft.

In patients who have been involved in a decelerating crush (e.g. traffic accident), or fall from a high place; aortic transection (AT) should be kept in mind and needs to be excluded due to its highly fatal course. The rapid transport of the patient to the hospital, an early diagnosis, and the type of treatment used are the factors that increase life expectancy in these patients.<sup>[1]</sup> Endovascular aortic repair is increasingly being used in these cases due to the lower mortality and morbidity rates associated with this procedure compared versus open aortic repair. In addition, parallel endograft techniques are becoming more popular for aortic pathologies that lack an adequate, safe landing zone.<sup>[2]</sup> In this case report, we present a patient with AT who successfully underwent the periscope graft technique for left subclavian artery (LSA) flow preservation during endovascular aortic repair.

### ÖZ

Künt torasik travmaya bağlı gelişebilen aortik transeksiyonlar aortik yaralanmaların en ölümcül olanıdır. Günümüzde, düşük morbidite ve mortalite oranları ile endovasküler aortik tamir tercih edilen tedavi yöntemidir. Güvenli bir yerleşme bölgesi sağlamak için sol subklaviyan arterin kapatılması gerekebilir. Böyle bir durumda, sol subklaviyan arter akımı baca veya periskop teknikleri ile korunabilir. Bu yazıda, akut aortik transeksiyonu için endovasküler aortik tamir yapılırken sol subklaviyan arter akımının devamı için periskop greft kullanılan 43 yaşında bir kadın hasta sunuldu.

**Anahtar sözcükler:** Aortik transeksiyon; baca greft; endovasküler tedavi; periskop greft.

### CASE REPORT

A 43-year-old woman who had been in traffic accident 10 days earlier was admitted to our hospital with a severe backache. Contrast-enhanced thoracoabdominal computed tomography angiography (CTA) was performed, and this showed a rounded bulge from the medial aspect of the aortic isthmus and an intimal flap compatible with AT that included a 35 mm segment (Figure 1). Additionally, nondisplaced fractures in the right eighth and ninth and left seventh costal bones along with focal lacerations in the pancreas and left kidney were noted. Hence, emergency endovascular treatment was planned. All of the patient's laboratory findings were within normal ranges.

Since the distance between the LSA and transection line (3 mm) was not safe enough to place a stent graft, we hypothesized that the origin of the LSA was

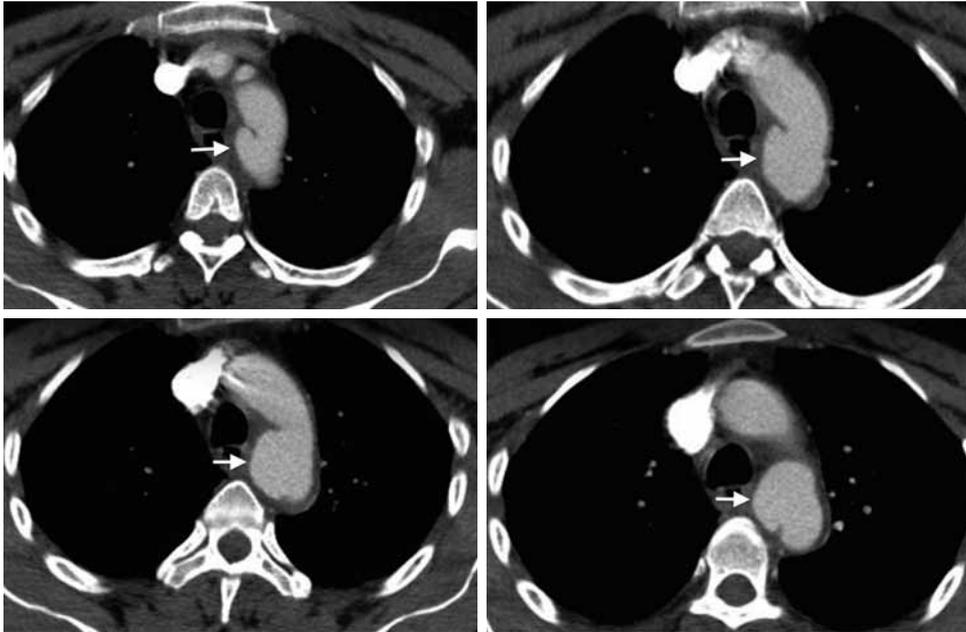


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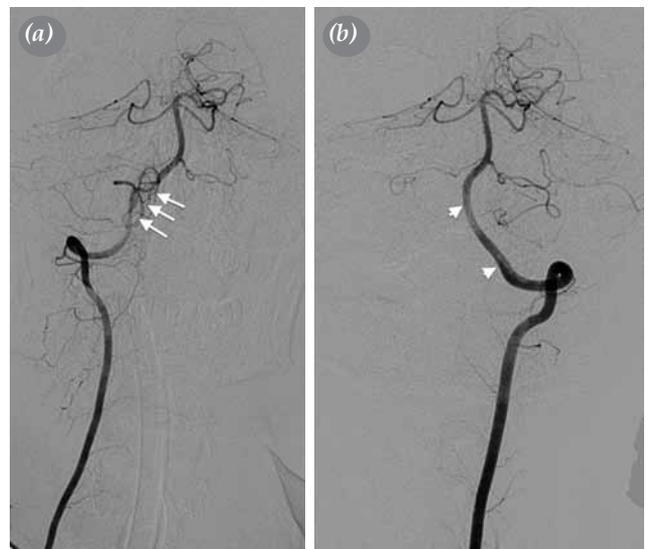
**Figure 1.** Sequential axial thoracic computed tomography angiography images show a rounded bulge from the medial aspect of the aortic isthmus wall (arrows) compatible with aortic transection.

occluded. A decision regarding additional endovascular or surgical reconstruction approaches for the LSA was postponed after the angiographic assessment of the vertebrobasilar system. The patient then completed the consent form and was taken to the angiography unit.

Right femoral access was obtained via open surgical cutdown under general anesthesia, and the left brachial and femoral arteries were cannulated with ultrasonographic guidance. The angiography of both vertebral arteries showed that the V4 segment of the right vertebral artery was hypoplastic but that it still had communication with the basilar artery. The left vertebral artery was dominant, and the right vertebral artery by itself was not considered to be sufficient to supply blood for posterior cerebral circulation and the left arm (Figure 2). Therefore, we decided to place a periscope graft inside the LSA instead of a chimney graft to avoid a potential type IA endoleak since the left carotid and subclavian arteries were in very close proximity (8 mm).

A 5-French pigtail catheter was then advanced upwards to the ascending aorta via the left brachial artery, and a 9x150 mm Gore® Viabahn® endoprosthesis (WL Gore and Associates, Inc., Flagstaff, AZ, USA) was advanced over an Amplatz guidewire (Boston Scientific., Heredia, Costa Rica) into the LSA just proximal to the left vertebral artery via the left femoral

artery. Subsequently, a 26x135 mm thoracic stent graft (Cook Medical, Inc., Bloomington, IN, USA) was advanced toward the arcus aorta over a Lunderquist guidewire (Cook Medical, Inc., Bloomington, IN, USA) via the right femoral artery (Figure 3). The thoracic



**Figure 2.** Digital subtraction angiographic images of both vertebral arteries obtained before aortic stent graft placement show that the V4 segment of the right vertebral artery was hypoplastic (a) (arrows) and that the communication with the basilar artery and left vertebral artery (b) (arrowheads) was dominant.

stent graft was released just distal to the left common carotid artery (CCA). As a final step, balloon dilatation was performed on the periscope graft simultaneously with the aortic stent graft after the periscope graft was released.

Postoperative angiography confirmed that the LSA and left vertebral artery flow was being maintained by the periscope graft in a retrograde fashion without any endoleaks (Figure 4). After an uneventful one-night intensive care unit follow-up, the patient was taken to the cardiovascular surgery ward. She was discharged on the third postoperative day and was prescribed 300 mg acetylsalicylic acid because of lacerations in the pancreas and left kidney. The postoperative third-day and third-month CT angiographies revealed a patent aortic stent graft together with a patent periscope graft without any endoleaks.

## DISCUSSION

Aortic transections are mostly seen at the aortic isthmus, with the underlying mechanism being a sudden

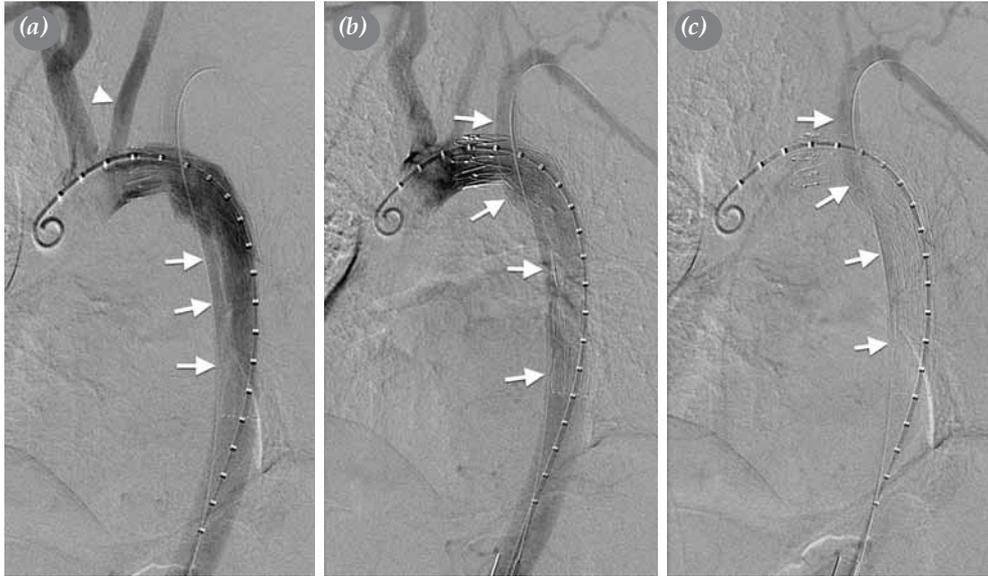
acceleration-deceleration movement which causes the inappropriate forward-back oscillation of the mobile and immobile parts of the aorta. Transverse tears often occur within the intima and a part of the media that frequently include all of the layers. Complete AT usually results in death in a few minutes. If the mediastinal pleura remains intact, broad retropleural bleeding can lead to acute hemorrhagic shock. In patients that survive this situation, the periaortic hematoma is reabsorbed over time and is transformed into a pseudoaneurysm. Additionally, in those with subadventitial localized ATs in which the aortic adventitia is protected in its entirety, as in our case, the mediastinal hematoma is limited or absent; hence, it is possible to overlook the diagnosis of subadventitial localized ATs.<sup>[3]</sup>

In cases of blunt thoracic trauma, it should be kept in mind that vascular injuries may have occurred, and the presence of mediastinal expansion, evanescence of the aortic contour, or tracheal deviation on chest roentgenography should be looked upon as suspicious. In these instances, the sensitivity and specificity of thoracic CT, including the arterial phase, for diagnosis is almost 100%.<sup>[4]</sup> Furthermore, transthoracic or transesophageal echocardiography as well as digital subtraction angiography may also be helpful for diagnosing this condition. Treatment alternatives for blunt thoracic trauma include surgical and endovascular interventions.

Endovascular aortic repair requires a minimum of a 20 mm safe landing zone. In cases in which the aortic isthmus injury is closer to the LSA, as in our case, the LSA orifice should be covered and the endograft should then be placed just distal to the left CCA. In patients who undergo LSA coverage during the thoracic endovascular aortic procedure, Lee et al.<sup>[2]</sup> determined that 6% have arm ischemia, 4% have spinal cord ischemia, and 2% have vertebrobasilar ischemia while 5% of these patients suffer a stroke due to anterior cerebral circulation and 6% do not survive. In order to reduce these risks, a complete evaluation of the vertebrobasilar system should initially be performed, and if necessary, additional surgical revascularization procedures should be carried out. Surgical options include a carotid-subclavian bypass graft, subclavian-carotid transposition, a carotid-carotid bypass, a subclavian-subclavian bypass, or an axillo-axillary bypass graft. Kukucer et al.<sup>[5]</sup> reported that the 10-year patency rates for these procedures can reach as high as 95%. Recently, the chimney and periscope techniques have been introduced as alternatives to extra-anatomical bypass surgery in



**Figure 3.** Digital subtraction angiography shows a pseudoaneurysmatic dilatation of the aortic isthmus that was compatible with aortic transection (big arrow), the partial release of the aortic stent graft positioned just distal to the left common carotid artery, and an unreleased, self-expandable covered stent (arrowheads) advanced proximally to the left subclavian artery just below the left vertebral artery (small arrow).



**Figure 4.** Sequential digital subtraction angiographic frame images (a-c) obtained just after the placement of the grafts show a patent thoracic stent graft placed just after the left common carotid artery (arrowhead) and a patent periscope graft (arrows) placed proximally from the subclavian artery to beyond the distal end of the thoracic stent graft. The left subclavian and left vertebral artery flows were provided by a periscope covered stent in retrograde fashion without any endoleaks.

order to protect the supra-aortic branches.<sup>[2]</sup> The main problem with these two endovascular techniques is that their long-term durability has not been clearly determined.

Although no consensus exists regarding the successful application of the chimney technique in the literature, it has been suggested that there should at least be a 10-15 mm distance between the target vessels. In a recent study by Moulakakis et al.<sup>[6]</sup> that analyzed reports that have focused on chimney graft applications for the supra-aortic branches, they found a total endoleak rate of 18.5% (type I endoleak 10.5%; type II endoleak 8%). In addition, they also noted that there was a technical success rate of 99.2%, a perioperative mortality rate of 4.8%, and a stroke rate 4%.

In selected patients with an insufficient distance between the left CCA and LSA, the periscope graft technique can be used instead of the chimney graft procedure to decrease the risk of a type I endoleak<sup>[7]</sup> since this is a particularly undesired complication, especially in cases in which a ruptured aortic transection is needed. Therefore any endovascular technique that might ensure the possibility of minimal endoleaks is of vital importance. With this goal in mind, we chose the periscope graft technique for our patient instead of the chimney procedure and obtained

successful technical and clinical results. Similarly, Lachat et al.<sup>[7]</sup> recently achieved positive results using the same technique to maintain LSA flow during endovascular aortic repair in 14 consecutive high-risk patients, including two with traumatic aortic ruptures.

### Conclusion

In patients with right vertebral artery hypoplasia or aplasia when there is a need to cover the LSA with an aortic endograft, previous surgical revascularization is needed to preserve posterior cerebral circulation. In emergency aortic transections that are performed when there is not enough time for subclavian artery reconstruction, endovascular salvage of the LSA using the periscope graft technique seems to be an effective, safe, alternative approach for these high-risk patients. However, further studies that feature long-term results with large patient cohorts are required to verify our hypothesis.

### Declaration of conflicting interests

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