An Unexpected Complication During Endovascular Aortic Repair: Covered-Stent Migration Into the Aortic Arch, and an Endovascular Solution: Case Report

Endovasküler Aort Tamiri Sırasında Beklenmeyen Komplikasyon: Kaplı-Stentin Arkus Aortaya Migrasyonu ve Endovasküler Çözümü

Levent ÇETİN,[a]
Murat CANYİĞİT,[b]
Aslıhan KÜÇÜKER,[a]
Mete HIDIROĞLU,[a]
Ayşegül KUNT,[c]
Erol ŞENER[a]

Clinics of
[a]Cardiovascular Surgery,
[b]Radiology,
Atatürk Training and Research Hospital, Ankara
[c]Department of Cardiovascular Surgery, Yüzüncü Yıl University Faculty of Medicine, Van

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Yazışma Adresi/*Correspondence:*
Aslıhan KÜÇÜKER
Atatürk Training and Research Hospital, Clinic of Cardiovascular Surgery, Ankara, TÜRKİYE/TURKEY
asliastan@yahoo.com

ABSTRACT Endovascular aortic stent-grafting has become a promising therapeutic alternative to open aortic surgery for all pathologies affecting the descending thoracic and abdominal aorta. A variety of unexpected complications related to these procedures may occur requiring prompt solutions. In those circumstances, knowledge of endovascular techniques and solutions are important. Herein, we present a worrying complication implying complete migration of the balloon-expandable covered stent of subclavian artery into the aortic lumen, and the endovascular solution of the problem. We believe that reporting such complications is important and informative, as it serves to pick up little but important tricks for our colleagues who perform similar endovascular interventions. We think that, we may learn from our complications, and share them with our colleagues in this way.

Key Words: Endovascular interventions; stent migration; left subclavian artery coverage; complication

ÖZET Endovasküler aort stent-greft uygulamaları, inen aorta ve abdominal aortayı içeren patolojilerin tedavisinde açık cerrahiye alternatif olan umut verici girişimlerdir. Bu girişimlerle ilişkili beklenmeyen komplikasyonlar da görülebilmektedir. Böyle durumlarda, endovasküler tekniklerin ve çözümlerin bilinmesi önem kazanmaktadır. Burada, subklavian artere ait balonla genişleyebilen kaplı stentin aortik lümen içerisine komplet migrasyonu şeklindeki oldukça can sıkıcı bir komplikasyonu ve endovasküler çözümünü sunmaktayız. Bu tür komplikasyonların bildirilmesinin, benzer girişimlerde rol alan arkadaşlarımız için ufak fakat önemli ipuçları yakalamaya hizmet edebilmesi nedeniyle önemli ve öğretici olduğunu düşünmekteyiz. Bu şekilde komplikasyonların öğreticiliğinden faydalanabileceğimize ve meslektaşlarımızla paylaşabileceğimize inanmaktayız.

Anahtar Kelimeler: Endovasküler girişimler; stent migrasyonu; subklavyen arter kapatılması; komplikasyon

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Endovascular aortic stent-grafts have become the preferred treatment choice for thoracoabdominal aortic pathologies with possibility for endovascular management of supra-aortic vessels. Complex aortic pathologies may require coverage of one or two aortic arc vessels. Endovascular handling of these challenging cases are increasingly performed. Consequently, the variety of related complications also increase. The incidence of intraoperative technical problems during endovascular interventions has been reported to be as high as 40% (81 patients of 204) including endoleak, graft kink and stenosis, deployment failure, thrombosis of the graft, aortoiliac rupture, renal artery occlusion and inadvertent internal iliac artery occlusion.[1] Technical problems and complications may occur during these 'closed' catheter-guided procedures. Here, we present a covered stent deployment with its subsequent complete migration into the aortic lumen, and our attempts to overcome this unpleasant complication.

CASE REPORT

A 61-year-old man was admitted to our hospital with back pain for the last two weeks. He had the story of endovascular stent-grafting for an abdominal aortic aneurysm two years ago. He neither used the prescribed medications nor came to control examination, because he did not have any complaints. Thoracoabdominal computed tomographic angiography showed a 27x20 mm saccular aneurysm of descending thoracic aorta distal to the left subclavian artery (LSA), and a saccular aneurysm with a small dissection flap in a depth of 7 mm, originating from proximal of LSA (Figure 1). Previously inserted abdominal aortic stent-graft was seen patent without any endoleak. The patient refused open surgical repair, therefore thoracic endovascular aortic stent-grafting for descending aorta, just after the origin of subclavian artery was planned. Since left vertebral artery was dominant, closing LSA was not preferred to avoid possible cerebrovascular events. Additionally, a covered-stent for the saccular aneurysm of the LSA was planned to be placed.

Surgical access to right common femoral artery and a percutaneous approach with 6F sheath for left common femoral artery were obtained under general anesthesia. Digital subtraction angiography (DSA) image confirmed the saccular aneurysm at the origin of the LSA (Figure 2A). Percutaneous left brachial artery access with an 11F sheath was done together with LSA stenting. A 16x41 mm balloon-expandable covered stent (Advanta V12, Atrium Medical Inc., Hudson, NH) was inserted to the proximal level of LSA via left

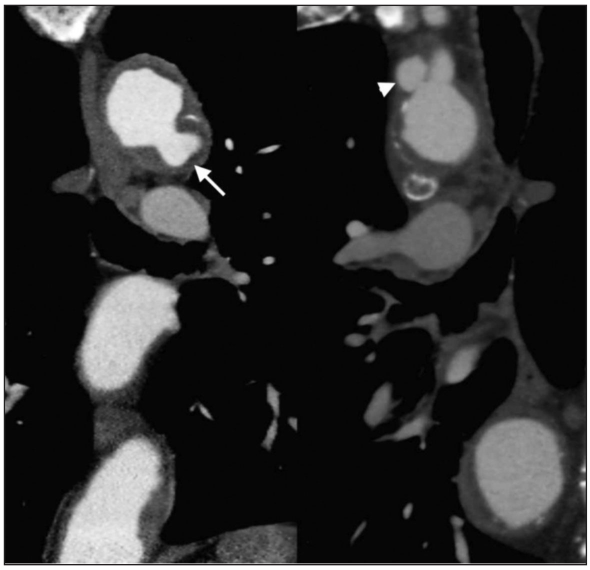

FIGURE 1: The long arrow shows the aneurysm of aorta, and the short arrow shows the aneurysm of the subclavian artery.

brachial artery over the Amplatz extra-support wire (Boston Scientific, Global Park, Heredia, Costa Rica). The covered-stent migrated distally during implantation, due to mismatch of proximal and distal subclavian artery diameters (15 mm and 11 mm at proximal and distal ends of subclavian artery, respectively). Arcus aortography showed the partial prolapse of the covered stent into the aortic arch. To solve this problem, we assumed that the aortic stent-graft would press the inadvertently migrated covered-stent, and would stabilize it as a chimney graft. We inserted a thoracic stent-graft over an extra-stiff guidewire (Lunderquist; Cook Inc., Bloomington, IN) via right femoral artery, located at the origin of LSA. While aortic stent-graft was advancing over the covered stent, the cover stent fully migrated into the aortic arch (Figure 2B). Therefore, aortic stent-graft was deployed after the LSA.

Subsequently, via the LSA, the balloon of the covered stent was inflated while it was in the covered stent to prevent an another inappropriate movement of the stent. While deflating the balloon slowly, the covered stent in the aortic arch was catheterized by a 0.035-inch standard hydrophilic stiff wire and a 5-Fr Bern catheter, that were advanced via left femoral artery. The balloon sent

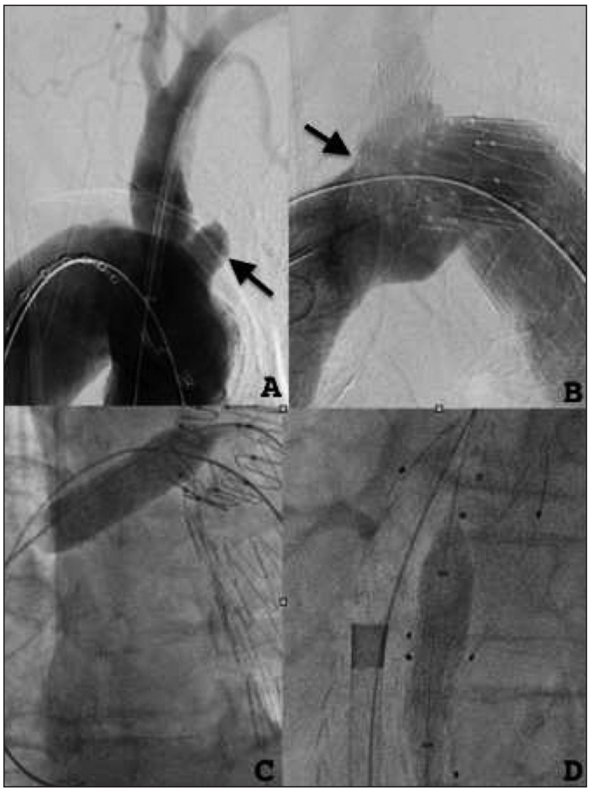

FIGURE 2: A) Saccular aneurysm at the origin of the subclavian artery. **B)** Partial migration of the stent graft for the subclavian artery into the aortic lumen. **C)** Fixation of the migrated graft with balloon dilatation. **D)** Insertion of the migrated stent-graft into the iliac leg of the previously inserted abdominal stent-graft.

from the LSA was removed, and relocated in the stent-graft via the left femoral artery over the stiff wire. The balloon was then inflated stabilizing the covered stent. This step allowed us to move the migrated covered stent with the balloon catheter (Figure 2C), and both were pulled back towards the abdominal aorta. Balloon and dropped stent-graft were pulled slowly back together to the proximal part of the left arm of the previously inserted abdominal aortic stent-graft, and inserted carefully. A control abdominal angiogram showed that this bothering covered stent finally settled in the left arm of the former aortic stent graft without any stenosis (Figure 2D).

The treatment of the saccular aneurysm at the origin of the LSA had to be postponed to a later intervention since there was no available smaller sized covered stent. The patient was discharged uneventfully on postoperative 4th day. In the follow up, the aneurysm size of the LSA orifice remained the same, and the patient refused another intervention. His 3rd year follow-up is uneventful without any increase in the size of the aneurysm.

DISCUSSION

Endoleak, stent migration, stent occlusion or break, graft infection, ischemic colitis, aortoenteric fistula, spinal cord ischemia, and non vascular complications as ulcer bleeding, acute cholecystitis and acute pancreatitis are the described complications of endovascular stenting.[2-4] A variety of device-related complications such as device compression, invagination, misaligned deployment, kinks, retrograde type A dissections and aortic perforation have also been reported in the literature.[5] In this case, we experienced a complication worse than a stent migration, but we could do an endovascular management. Open surgery always remains an option for intraoperative complications, but conversion to an open procedure was reported to have a higher mortality rate (33%).[1] Therefore, we tried to find an endovascular solution, and fortunately we could.

In endovascular stent-grafting of thoracic aorta (TEVAR), there is no consensus for the management of LSA. Suitable proximal and distal landing zones for stable stent-graft fixation is essential, therefore 2 cm of normal aortic wall is required for adequate and stable sealing. When the distance between the LSA and aortic lesion is too short or the LSA ostium is located within the aortic pathology, extension of the landing zone can be obtained by covering the LSA's origin with the endovascular stent-graft.[6] However, this maneuver has the potential for immediate and delayed neurological and vascular symptoms. Coverage of LSA is reported to result in an increased prevalence of left arm ischemia, stroke and the need for an additional procedure.[7] Criado et al. reported that LSA coverage was apparently safe, but they recommend to ascertain the angiographic patency of the contralateral vertebral artery beforehand, with secondary revascularization being easily achievable if vertebrobasilar or arm ischemia develops after stent-graft placement.[8] Schoder et al. performed primary surgical revascularization of the LSA in patients with a dominant left vertebral artery with a marked stenosis of the right vertebral artery or an occluded internal carotid artery. They concluded that before intentional LSA occlusion, one shouldd evaluate the carotid arteries, vertebral arteries as well as the circle of Willis, to minimize the risk for ischaemic cerebral disorders.[9] A recent study reviewing 23 relevant articles about LSA management in TEVAR patients identified three basic treatment strategies as prophylactic, conditional prophylactic and no prophylactic LSA revascularisation, and gathered evidence supporting prophylactic revascularisation of LSA should be done if preoperative imaging revealed abnormal supra-aortic vascular anatomy or pathology. They concluded that elective TEVAR patients with planned LSA coverage should receive prophylactic LSA revascularisation to prevent severe neurologic complications such as paraplegia or brain stem infarction.[6] In our clinical practice, we perform prophylactic LSA revascularization only under certain conditions, including any pathologies involving supra-aortic vessels or in the presence of a dominant left vertebral artery.

Surgical or endovascular approaches with branched stent-grafts are the current strategies for LSA revascularisation. Surgical procedures such as LSA transposition or carotico-subclavian bypass (between LSA and left common carotid artery) have been the preferred surgical approaches for LSA revascularisation. The use of chimney grafts has been recommended in selected aortic arch pathologies with involvement of supra-aortic branches. Endovascular debranching with a chimney technique for supra-aortic vessels (innominate, left common carotid artery or LSA) can reduce, or may even eliminate the need for surgical bypass by inhibiting coverage of arch vessels in complex thoracic aortic pathologies.[10,11] In situ retrograde laser fenestration is another endovascular approach suggested for revascularizing the LSA during emergent TEVAR.[12] Authors reporting chimney grafts in the supra-aortic branches to be feasible are increasing, and they conclude that these grafts may facilitate the procedure in patients with an inadequate proximal neck.[13]

In this patient, we did not prefer to place a chimney graft inside the LSA because there was a 2 cm distance between the thoracic aorta aneurysm and LSA. Instead, we preferred to close the LSA's saccular aneurysm with an Atrium iCast balloon-expandable stent-graft. Because the proximal diameter of the LSA was 15 mm and self-expandable Viabahn covered stents have 13 mm sized stents in maximum, we used balloon expandable stents. Unfortunately, since we chose the subclavian stent due to the larger diameter at the proximal instead of the smaller diameter at the distal subclavian artery, and the stent migrated towards the aorta during balloon expansion. We assume that we probably would not experience such a complication if we chose a smaller stent fitting the smaller distal diameter, and a larger sized stent for the proximal part. We presented a complication of our early experience aiming to give an idea about the importance of sizing during endovascular interventions. We conclude that, if Atrium iCast balloon-expandable stent will be used in cases with vessel diameter discordance, it seems wiser to choose the stent fitting the region with a smaller diameter, and to perform an additional balloon dilatation for the region with a larger diameter.

In conclusion, endovascular interventions for pathologies involving aorta and its branches are widely used in the current clinical practice all over the world, with the possibility to handle more complicated cases with technical improvements. Consequently, a variety of complications related to these procedures are being reported. In such unexpected situations, prompt solutions are to be found in the operating room. In the present case, we report a complication of totally migrated LSA covered stent and the endovascular solution we performed to overcome this unpleasant complication.

Conflict of Interest

Authors declared no conflict of interest or financial support.

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