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Case report

# Endovascular repair of isolated post-traumatic subclavian artery false-aneurysm (FA) using gore viabahn vbx-balloon-expandable (BE) stent-graft: case report and literature review

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**Abstract.** True and false aneurysms (FA) of the subclavian artery are at high risk of rupture due to their localization and proximity/closeness to the articular bone structures of the upper thoracic outlet and shoulders. Surgical and endovascular treatments are good options to avoid complications such as aneurysms rupture, thrombosis and distal embolism alone or in combination. Self-expandable (SE) covered stents are the most used devices for the treatment of subclavian artery aneurysms. We report on a case of post traumatic left intrathoracic subclavian artery FA treated using endovascular technique, highlighting the usefulness of the new covered Gore Viabahn VBX-BE stent-graft that combines the advantages of a high radial strength of a BE stent with the deliverability and conformability of a SE stent. (www.actabiomedica.it)

**Key words:** Subclavian artery aneurysm, self-expandable stent, balloon-expandable stent, true aneurysm, false aneurysm.

## Introduction

True and false aneurysms (FA) of the subclavian artery are quite rare, accounting for around 1% of all peripheral aneurysms[1-5]. Atherosclerotic processes and tissue disorders[3-6] cause the growth of true aneurysms in the proximal tract of the subclavian artery while traumatic and cannulation injuries[7] may induce false aneurysm development mainly in the distal tract. Thoracotomy or supraclavicular incisions are described as conventional surgery techniques with satisfactory results of long-term vessel patency up to 9.2 years[8-10]. On the counterpart, they are characterized by 26% and 8% morbidity and lethality rates[1]. Endovascular treatment with stent-graft placement is an alternative approach to conventional surgical repair and, although published experiences are still limited, begins to represent an appealing and less invasive strategy[11-18]. In this paper we describe a case of post traumatic left intrathoracic subclavian artery FA treated by endovascular technique using Gore Viabahn VBX-BE stent-graft.

## Case Report

In January 2021, a 67-year-old male patient was admitted to the emergency department of our hospital for a bicycle accident. On physical examination the

patient presented pain with a pulsating mass in the left supraclavicular region. Initial x-ray study of the left hemithorax showed middle third clavicle, scapula body, coracoid process and various ribs fractures (**Fig.1a**).

An ultrasound (US) examination of the mass (**Fig.1b**) showed a pulsatile hematoma (**Fig.1c**,**d**). A computed tomography(CT) scan identified an enhanced FA of the middle third of the left subclavian artery (**Fig.1e**). Written informed consent was obtained by the patient who was then admitted to the angiography room. The angiogram performed via the right femoral artery access confirmed the large FA originating from the left subclavian artery. Through direct puncture of the left brachial artery an 8Fr introducer sheath was placed. The Balloon Expanding Stent (Gore Viabahn VBX-BE Endoprosthesis 8x59 cm mounted on 80cm-long catheter) was introduced (**Fig.2a**) and stretched to 10 atm (8 mm) with its pre-assembled balloon(**Fig.2b**,**c**); then the stent-graft was modeled with 10 and 12 mm balloon catheters (**Fig.2d**,**e**). Subsequent control angiogram did not demonstrate FA endoleak with adequate flow inside (**Fig.2f**). Access sites were closed by manual compression and with 6Fr Angioseal closure system respectively on the left arm and the level of right femoral artery. After that the patient underwent a fracture stabilization intervention by positioning midshaft clavicle plate (**Fig.2f**).

Before discharge an US was performed showing a patent endograft with regular systo-diastolic flow. The patient was discharged with double anti-aggregation therapy for six weeks but one month

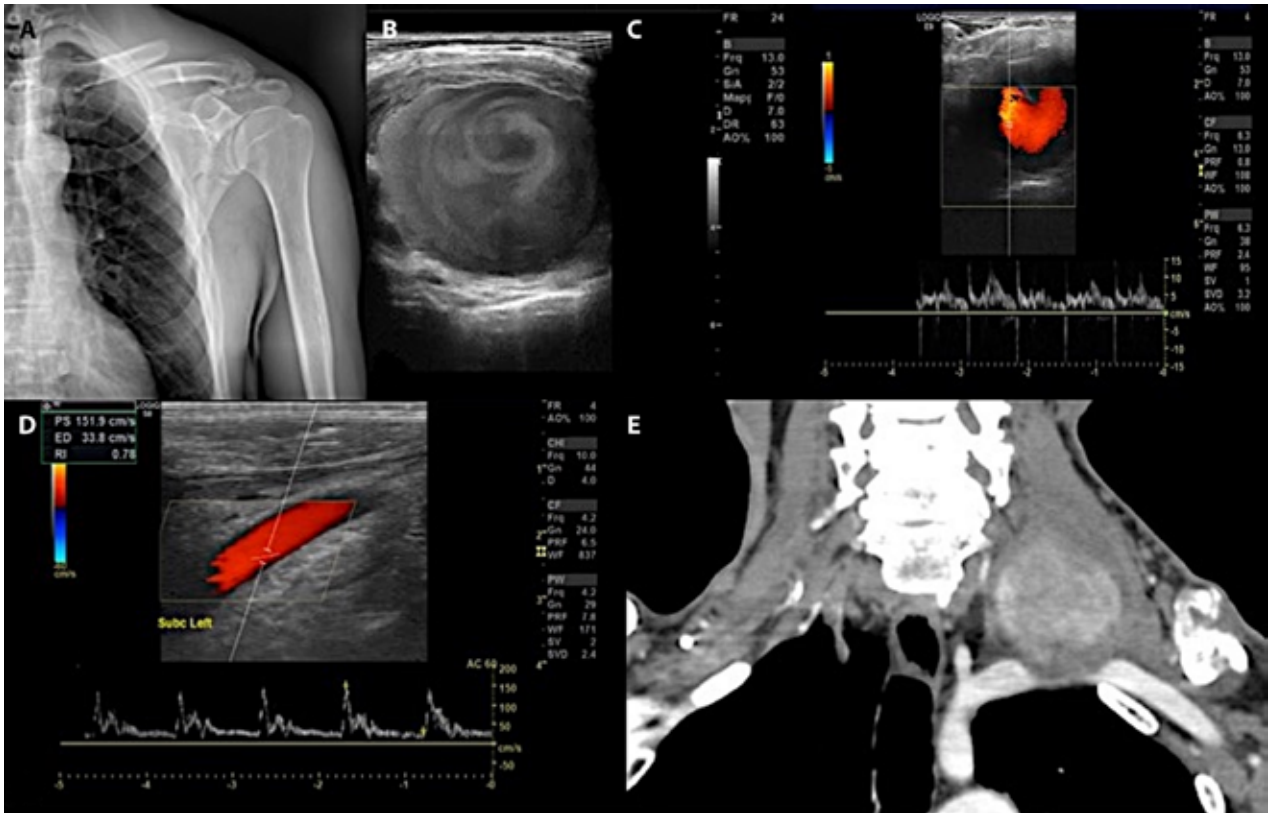


**Figure 1.** (a) Frontal left hemitorax x-ray projection that shows middle third clavicle, scapula body, coracoid process, IV,V and VI rib fractures combined with moderate soft tissue density in the left supraclavicular region. (b,c,d) ultrasound(US) and doppler images of the pulsatile hematoma with inside arterial-type Doppler flow signal; a regular flow was found in the ipsilateral subclavian artery(d). Frontal plane image (e) of an Angio CT multi-planar-reconstruction (MPR) that shows enhanced FA of 8x5x6 cm with no evidence of clear signs of rupture, originating from the medial tract/middle third of the left subclavian artery after the origin of the ipsilateral vertebral artery.

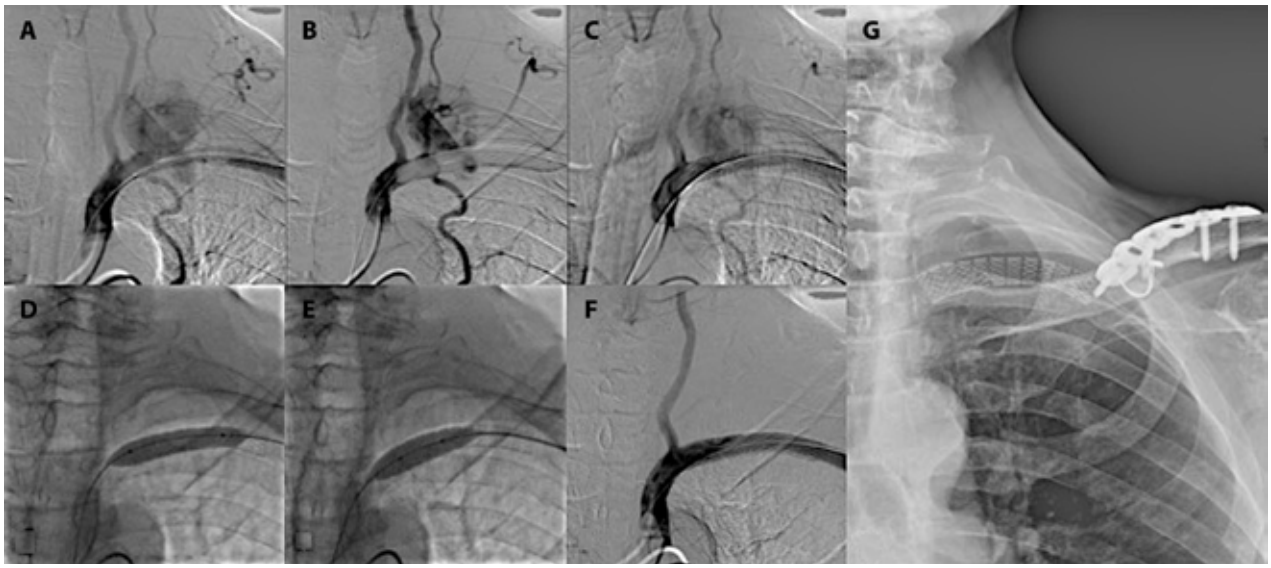


**Figure 2.** Different digital subtraction angiograms (DSA) performed via the right femoral artery access and catheterization of left subclavian artery. The images (a,b) shows the VBX-BE positioned with the proximal end distally to the level of the left vertebral artery before(a) and after dilation (b) with its pre-assembled balloon. The image (c) shows no complete FA exclusion after the first dilation of the device. The fluoroscopic images (d,e) show proximal portion stent-graft remodeling respectively with 10 and 12 mm balloon catheters. DSA image (f) obtained at the end of the procedure demonstrating no FA endoleak with adequate flow through the graft; at the same time this image shows patency of the subclavian artery distal to the stent graft and vertebral artery with exclusion of the ipsilateral internal mammary artery and thyrocervical trunk. (g) Frontal x-ray projection that shows fracture stabilization by positioning midshaft clavicle plate after the endovascular procedure.

after the procedure he presented with critical left upper limb ischemia (Rutherford's category IV). He underwent an angiographic examination which documented acute thrombotic occlusion of the stent graft (**Fig.3a**). Stent recanalization was performed with placement of a fibrinolytic catheter and bolus release of 200,000 IU of Urokinase and 5000 IU of heparin (Fig3b). Fibrinolytic therapy was continued for a day after which angiographic control documented incomplete recanalization (**Fig.3c**). The treatment was completed with balloon angioplasty (Fig3d) obtaining an almost complete patency of the stent without signs of FA endoleak (**Fig.3e**). The patient was subsequently discharged with double antiplatelet therapy for three months after which single antiplatelet therapy but four months after the procedure complained again of a left upper limb moderate occlusive vascular symptomatology (Rutherford's category II). We documented an incomplete expansion of the stent-outflow (Fig3f,g,h) and postulated that was due to a moderate impingment by the clavicular bone synthesis plates on the stent during shoulder and arm movements. Therefore an orthopedic surgical revision of the plate with screws repositioning (**Fig.3i**) was performed. Then angiografic exam confirmed the stenosis (**Fig.3l**) and an angioplasty (**Fig.3m**) was performed, with a good stent final patency (**Fig.3n**,o). The patient received at the last the same medical therapy with double antiplatelet for three months after which single antiplatelet administered in the previous discharge.

## Discussion/Conclusion

The main causes of all subclavian artery aneurysm development include trauma, atherosclerosis, thoracic outlet syndrome, and iatrogenic trauma with percentages respectively of 33-37%, 18-19%, 18% and 10%[1-5]. About 75% of subclavian artery aneurysms are asymptomatic and due to vascular degenerative atheromasia, while in the remaining cases, such as in trauma, they can lead pain or rupture with ischemic symptoms from thromboembolism and life-threatening complications[2]. Median surgical sternotomy and thoracotomic

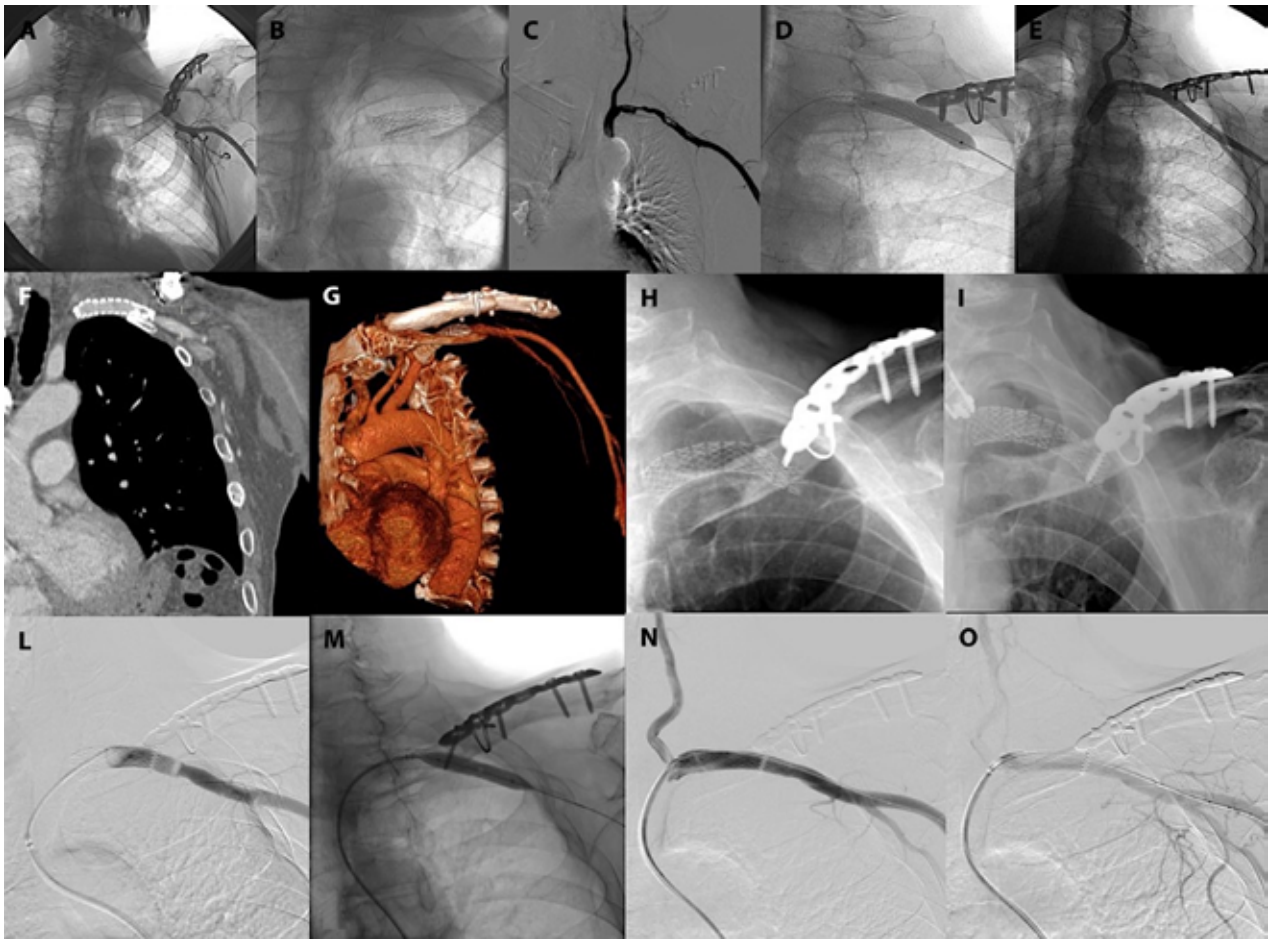


**Figure 3.** Digital angiography (DA) image (a) obtained by MDC injection from the left brachial arterial access that shows thrombotic occlusion of the device treated previous fibrinolytic catheter positiong (b). DSA image (c) reveals incomplete recanalization with thrombus adjacent to the wall of the stent after fibrinolytic therapy. Fluoroscopic image (d) that shows balloon angioplasty at the end of the fibrinolytic therapy and post control DA image (e) with evidence of almost complete patency of the stent without signs of FA endoleak. Frontal plane image (f) of Angio CT multi-planar-reconstruction (MPR) that shows circumscribed small caliber reduction at the stent outflow; (g) left antero-lateral 3D-image CT reconstruction and (h) frontal x-ray projection that prove the impingment by the clavicular bone synthesis plates on the stent. (i) Frontal x-ray projection obtained after orthopedic surgical revision of the plate with screws repositioning that reveals no apparent contiguity with the stent. (l,n,o) Different subtracted angiograms performed via the right femoral artery access and catheterization of left subclavian artery. The DSA image (l) shows the small VBX-BE outflow caliber reduction. After dilation with 8X40mm balloon (m) control DSA images (n,o) show respectively complete FA exclusion with adequate flow through the graft, and late onset of retrograde flow in the thyrocervical trunk.

access at the posterolateral level third or fourth intercostal space are respectively surgical accesses to right and left intrathoracic subclavian artery aneurysms; repair of middle or distal subclavian artery aneurysms is performed by supraclavicular and infraclavicular incision with resection of the first rib, taking into account that manipulations in the periclavicular area might possibly result in an injury to the brachial plexus[6]. Currently there are no clear contraindications to the endovascular treatment[18-23] of subclavian artery aneurysms and some exceptions concern the aneurysm size and its intra or extrathoracic position. Some authors[24] reported the deployment of a covered self-expanding stent as a means to exclude the aneurysm. One of the latest retrospective studies is by Tanmit et al[25] compares the outcome of thirty patients and does not find significant differences in terms of efficacy between surgical and endovascular treatment. Although at risk

of endograft thrombosis or aneurysm endoleak and in agreement with these data[25] we can confirm that the endovascular management is low invasive without significant need for red blood cell transfusions with short hospital stay. In our experience we chose to implant the Gore Viabahn VBX BE endoprothesis (8X59mm). This stent is made up of discrete fluoropolymer-connected stainless steel rings that provide high radial strength, excellent radiopacity, flexibility, conformability, trackability, and minimal foreshortening with the possibility of post-dilating the labeled device diameter up to + 4mm; furthermore the endoprothesis is coated with the CARMEDA BioActive Heparin Surface consisting of stable, covalent, reduced-molecular-weight heparin of porcine[24-26]. In our case thrombosis and mild kinking of the stent occurred after 1 and 4 months despite the interface heparin characteristic and optimal radial strength of the stent due to movements of the patient's arm. Despite these events we were able to perform again an angioplasty and to dilate the device for its properties with good final result after repositioning of plate screws. To conclude, the natural history of subclavian artery aneurysms is unknown but at high risk of complications and mortality thus immediate management is important and consists in the rapid and accurate evaluation of the patient's condition. Diagnosis can be confirmed with computed tomography angiography (CTA) but the use of doppler ultrasound could play a role in very severe cases providing crucial information for critically unstable patients. Many of these cases need of open vascular repair achieved through adequate exposure, proximal and distal control of the flow and ultimately with the restoration of perfusion. Endovascular treatment is less invasive than conventional open surgical reconstruction, in our opinion useful for safeguarding the integrity of adjacent nerve and muscle tissues, and thus an alternative and conservative approach using stent-assisted recanalization technique with the aim of perfusing the limb.

**Conflict of interest:** Each author declares that she or he has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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