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Case Report

Computed tomography venography of the upper extremities — Using low dose bilateral contrast media injection in a patient with suspected venous thoracic outlet syndrome

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ABSTRACT

Venous thoracic outflow syndrome may occur as a result from compression of the subclavian and/or axillary vein and consequently, decreased blood flow and increased risk of thrombus formation. A previously healthy 34-year-old woman who, after intensive crossfit training, experienced sudden intense pain and swelling in her right upper arm was referred for computed tomography of her right upper arm and thoracic veins. The computed tomography was performed using bilateral injection of low dose, diluted contrast medium. The computed tomography venography revealed an elongated contrast medium embraced thrombus in the right subclavian and axillary vein. By using a dual injection consisting of diluted contrast medium, artifact-free visualization of arm veins and sufficient enhancement of thoracic veins can be achieved.

Introduction

Approximately 10% of all documented cases of deep vein thrombosis (DVT) occur in the upper extremities. The incidence of upper extremities deep vein thrombosis has been reported to be between 0.4-1 cases per 10,000 [1]. Thoracic outlet syndrome (TOS) can be referred to compression of upper extremities nerves, veins and arteries where they leave the thoracic cavity. The most common cause of TOS is neurogenic compression which accounts for >90% of all cases, followed by vein compression 3%-5%, and arterial compression <1% [2,3]. Venous thoracic outlet syndrome (VTOS) as described in this case study can be caused by:

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positional obstruction without thrombus formation (McCleery syndrome), vascular injury and thrombus formation associated with the introduction of a central venous catheter, and effort thrombosis also known as Paget-Schroetter syndrome (PSS) [4,5]. PSS is a rare condition that usually affects young athletes or in persons performing hard labor. PSS occurs when the axillary vein or subclavian vein is compressed by the first rib, clavicle and/or by its surrounding musculature. Due to repeated compression of the axillo-subclavian vein, inflammation and growth of fibrotic tissue occur, leading to intraluminal constriction followed by decreased blood flow leading to thrombus formation with secondary increased risk of developing pulmonary embolism (PE). A 20%-30% increased risk of PE has been reported in patients with PSS.

Treatment of patients with PSS includes anticoagulant therapy, catheter-directed thrombolysis, and surgical decompression [6–9]. The use of stents in patients diagnosed with PSS has in some cases been found to cause complications. Due to the influence of surrounding tissue, stent deformation or even stent fracture has been reported [10,11]. There are several noninvasive techniques to evaluate PSS. The most common technology and also the one considered to be gold standard is Doppler ultrasonography (DUS). However, DUS is user dependent and the lack of images easy to interpret for the clinician makes alternative imaging and diagnostic techniques desirable. Other difficulties are overlying osseous structures that is clavicle, which limits the sound beam penetration. But also, in cases of central extension of intraluminal pathologies may not be evaluated due to its deep positioning [12–15]. Alternatives to an inconclusive DUS are magnetic resonance imaging or computed tomography venography (CTV) [16–18].

Case study

After months of regular intensive crossfit training a previously healthy 34-year-old female experienced swelling, pain and visible collateral veins in her right upper arm. DUS revealed thrombus of the right subclavian vein. After anticoagulation therapy the condition decreased, but the swelling and the presence of collateral veins still remained. To map the venous system the patient was referred for contrast media (CM) enhanced CTV of the right arm and central veins. The CTV was performed using a dual source multidetector Somatom Definition Flash (Siemens Healthcare, Forchheim, Germany). Scan parameters included helical scanning using 128 × 0.6 mm detector collimation at a pitch of 0.9, 100 kVp, and automatic tube current modulation. Based on previous clinical experience [15], a solution of CM and saline was used to fill 2 syringes attached to a power injector (Medrad, Stellant Dual Head Injector, Bayer, Pittsburgh, PA, USA). The solution in each syringe consisted of 90 mL saline and 10 mL CM (Iomeron-400 mg iodine per mL, Bracco Imaging SpA, Milan, Italy). 45 mL was injected simultaneously in both the left and right medial cubital vein at 4 mL per second through an 18-gauge percutaneous venous catheter. The total dosage of CM was 3.6 grams of iodine. The patient was scanned with arms comfortably down in caudo-cranial direction with a 12-second scan delay after injection start. The CTV revealed an elongated CM embraced thrombus in the right subclavian and axillary vein (Fig. 1). The right subclavian vein was tapered just before the confluence with the internal jugular vein (Fig. 2). At the site of this constriction, no CM embraced thrombus could be detected. Several collateral veins were visualized in the right supraclavicular fossa (Fig. 3). After the CTV it was decided to continue anticoagulant therapy. At follow-up DUS 3 month later small remnant thrombus residue in the wall of the right proximal subclavian vein could be observed. Anticoagulant therapy was discontinued a few weeks later.

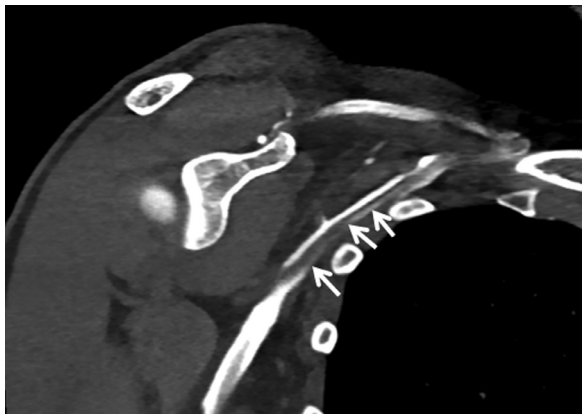

Fig. 1 – Coronar projection showing an elongated contrast media (CM) embraced thrombus in the right subclavian and axillary vein (arrows).

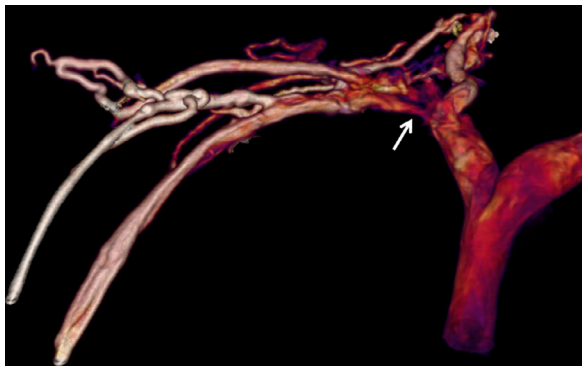

Fig. 2 – Volume rendering image (VR) showing constriction of the right subclavian vein (arrows).

Discussion

The CM injection protocol used in this case study was based on clinical bilateral injection protocol used in CTV of the upper-extremity in patients with impaired renal function [19]. In this case study a total dose of 3.6 gram of iodine was used, which is less than a 10th of the dose of iodine that is commonly used for a standard CT thoracic examination. Despite the low dosage of CM, upper extremities veins were

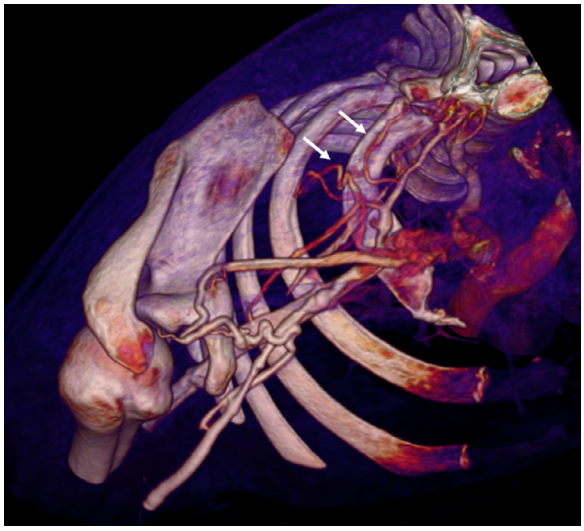

Fig. 3 – VR image showing generated collateral vessels in the right upper extremity (arrows).

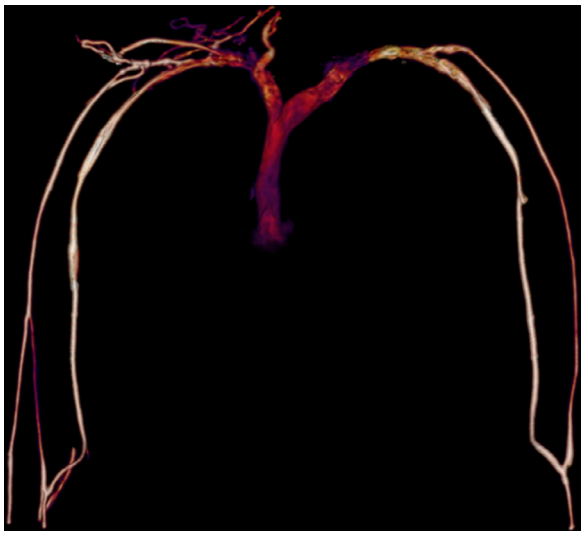

Fig. 4 – VR image showing simultaneous bilateral CM injection providing sufficient enhancement of the arm veins bilaterally, right and left brachiocephalic vein, and superior vena cava.

sufficiently opacified (approximately 500 Hounsfield units) which clearly define the thrombus in the right subclavian and axillar vein (Fig. 1). In addition to the reduction of iodine load, which is of importance in patients with renal impairment, there are several advantages of using a diluted CM solution. The most important is that the veins of the upper extremities can be scanned during the first CM passage. Compared to the standard procedure where undiluted CM is injected and scanning is performed at the second passage, the high-density artifacts from undiluted CM remaining from first passage is completely avoided. A simultaneous bilateral CM injection also makes correct timing easier as it provides sufficient enhancement of the arm veins bilaterally, right and left brachiocephalic vein, and superior vena cava (Fig. 4).

Conclusion

By using a dual injection consisting of diluted contrast medium, artifact-free visualization of arm veins and sufficient enhancement of thoracic veins can be achieved.

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