Chest wall varicose veins: did you see that?

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Learning objectives

The learning objectives of this educational exhibit are:

• To recognize common and often missed presentations of chest-wall varicose veins.
• To review and illustrate the complex venous anatomy of the thorax and how venous pathology can present, using different imaging techniques.
• To review the applicability of different imaging techniques in the diagnostic workflow of selected cases.
Background

The chest wall is often neglected in the chest's imaging evaluation and it's hardly the main focus of attention in the referring physicians' mind. However, subtle changes in its venous drainage pathways can often represent venous pathology elsewhere with important clinical implications. It's not uncommon for a patient to seek help from multiple different specialisms for vascular changes in target organs before arriving at the final diagnosis. Imaging evaluations restricted to particular anatomical territories (failing to see the whole and bigger picture) can further add to the confusion.

Venous interventions are increasing in modern medical management of patients, from hemodialysis vascular accesses to long-term central venous catheters for delivery of oncological treatments. The complications related to such interventions are increasing as well.

The dynamic nature of the complex venous anatomy and the different presentations it can have must be fully understood and accounted for at the risk of under-diagnosing significant and treatable pathology.

Venous anatomy of the thorax

Venous drainage of the thorax can result from either the inferior vena cava (IVC), draining the abdominal viscera and the somatic venous return; the azygos system, draining the somatic abdominal venous return and the somatic and visceral venous return from the chest; the brachiocephalic veins (through the internal thoracic and the first posterior intercostal veins); and the superior vena cava (SVC) draining the venous return from the head, neck and upper limbs through the azygos and brachiocephalic systems. Only the IVC and the SVC enter the right atrium directly.

IVC

The IVC has a diameter around 30 to 40mm as it enters the right atrium. It has an oval shape, which is held rigidly open by the support provided by both the fibrous cardiac skeleton and the liver parenchyma.

Azygos Venous System

The azygos system includes the azygos vein, the hemiazygos vein and the accessory hemiazygos vein.
The azygos vein proper enters the SVC after contouring the right main bronchus.

The hemiazygos vein follows contralateral to the azygos vein and ends around the level of T8, crossing the midline and joining the azygos vein proper.

The accessory hemiazygos vein follows the upper thorax from the left side, ending inferiorly either joining the hemiazygos or crossing the midline and joining the azygos vein directly.

Both the azygos and the hemiazygos veins originate from the retroperitoneum, usually from the confluence of a subcostal and the ascending lumbar veins.

**Somatic Venous Drainage of the Neck**

The brachiocephalic veins drain the neck through the vertebral veins, inferior thyroid veins, internal mammary veins, supreme, left superior and occasionally the right first intercostal veins.

The internal jugular vein receives tributaries from the superior and middle thyroid veins and gives a communicating branch to the external jugular vein.

The external jugular vein also receives the venous return from the transverse cervical, suprascapular and anterior jugular veins, allowing venous drainage from the contralateral neck through the anterior jugular arch, which also drains the inferior thyroid veins.

**Somatic Venous Drainage of the upper extremity**

The basilic vein drains into the axillary vein. After the axillary vein receives the cephalic vein it continues as the subclavian vein.

The axillary vein also drains venous branches from the chest wall, namely the pectoral branch of the thoracoacromial vein, the lateral thoracic vein and the thoracodorsal vein.

Communication between the axillary vein and the external jugular vein is accomplished by a communication branch from the cephalic vein and from anastomoses between the subscapular vein (tributary of the axillary vein) and the transverse cervical and suprascapular veins, which drain to the external jugular vein.

**Somatic Venous Drainage of the Chest**

The venous drainage of the chest wall is asymmetric and prone to variations.
The posterior intercostal veins of the chest include the first (also called the supreme) posterior intercostal vein, which drains to the brachiocephalic or vertebral veins on each side; the superior intercostal vein, which drains both the second and the third intercostal spaces; the lower eight posterior intercostal veins on the right, which drain directly into the azygos vein proper; and the lower eight posterior intercostal veins on the left, which drain to the hemiazygos (lower four) and to the accessory hemiazygos vein (upper four). The posterior intercostal veins are responsible for draining most of the chest wall’s venous return. The internal and external vertebral venous plexus drain to the thoracic intervertebral veins, which ultimately drain also to the posterior intercostal veins.

The posterior intercostal veins communicate with the lateral thoracic, anterior intercostal and internal mammary veins.

The anterior intercostal veins drain to the internal thoracic vein on each side, which joins the brachiocephalic vein. The anterior intercostal veins are thinner and often paired.

**Visceral Venous Return of the Chest**

Venous return from the thoracic esophagus can occur to either the brachiocephalic veins (upper third), the azygos system (middle third) or to the left gastric vein (lower third). These postosystemic anastomoses between the esophageal and the left gastric veins are responsible for the variceal dilatation that occurs in portal hypertension.

The drainage of venous return from the lungs and airways occurs through two systems: the superficial and the deep systems.

The superficial system results from the confluence of veins at the pulmonary hilum, draining the larger airways and the adjacent visceral pleura. From this venous confluence, a pair of bronchial veins arises and drains into the pulmonary veins while also communicating with the pulmonary veins.

The deep system drains the pulmonary parenchyma and the remaining (most) visceral pleura, through the pulmonary veins.

The venous blood that reaches the right atrium is a mixture of oxygen depleted systemic venous return and oxygen rich pulmonary venous return.

The esophageal, mediastinal and occasionally the bronchial veins drain into the intercostal veins, with may communicate through anastomotic connections to the thoracodorsal vein and the pectoral branch of the thoracoacromial vein.

**Collateral venous pathways**
The rich venous anastomotic network of the thorax explains why venous stenosis and occlusions can be bypassed with maintenance of the blood return to the right atrium. While this allows for hemodynamic compensation, it is done at the cost of recruiting and overloading other venous territories, leading to enlarged abnormal veins.

In specific settings, like in the case of hemodialysis vascular accessed or central venous lines, where a large volume of flow is expected to be drained, these compensatory adjustments of the venous system can prove to be insufficient and lead to dysfunction of the access or catheter.

A few decades ago, venous obstruction in the thorax was essentially caused by SVC obstruction, mainly due to neoplasia. With the advent of central venous catheters and hemodialysis vascular accesses in the upper limb, stenotic lesions involving the axillary-subclavian segment are increasingly more prevalent.

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<th>Shoulder to chest wall</th>
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<td>Veins in the external chest wall drain preferentially to the axillary veins</td>
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<td>Flow reversal of the external chest wall allows drainage of venous return of the upper extremities through the intercostal veins</td>
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<th>Shoulder to ipsilateral anterior neck</th>
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<td>Are uncommon but can occur through the inferior thyroid or the internal mammary veins</td>
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<th>Shoulder to ipsilateral posterior neck</th>
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<td>Occurs due to collaterals from the subclavian to the vertebral vein via collaterals developed in the intramuscular venous branches of the neck.</td>
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<th>Shoulder to contralateral neck</th>
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<td>Through the jugular venous arch between both external jugular veins.</td>
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**Collateral pathways that bypass the axillary-subclavian venous segment**

**Venous collateral pathways around the chest wall**

Axillary or subclavian vein stenosis or occlusion

- Collateral flow through muscular and superficial veins around the shoulder, scapula and chest wall, with drainage of venous return into the ipsilateral internal jugular vein, intercostal veins or contralateral jugular or subclavian veins
Brachiocephalic vein stenosis or occlusion

- Collateral flow through deep and superficial veins around the chest wall (including the dorsum) and neck veins, draining into the contralateral jugular, subclavian and brachiocephalic veins.
- Collateral flow through the superficial chest wall veins (e.g. internal mammary and intercostal veins) into the azygos venous system (azygos proper, hemiazygos or accessory hemiazygos veins) or into the inferior epigastric veins.

SVC occlusion above the azygos vein confluence

- Collateral flow through chest wall and intercostal veins, draining into the azygos venous system.

SVC occlusion below the azygos vein confluence

- Collateral flow through the azygos vein, with reversal of flow direction (retrograde) into the IVC

SVC occlusion above and below the azygos vein confluence

Collateral flow through chest wall and intercostal veins, into the azygos venous system with retrograde drainage into the IVC
Images for this section:

**Fig. 1:** Inferior Vena Cava

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Fig. 2: The azigos venous system

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**Fig. 3:** Posterior view of the azigos system: The azygos proper drain into the SVC; The hemiazigos and the accessory hemiazigos drain into the azigos proper vein

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**Fig. 4:** The Somatic Venous Drainage of the Neck

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Fig. 5: Somatic Venous Drainage of the upper extremity

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Fig. 6: Somatic Venous Drainage of the upper extremity

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Fig. 7: Somatic Venous Drainage of the Chest

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Fig. 8: Somatic Venous Drainage of the Chest Posterior view

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Fig. 9: Shoulder to chest wall Flow reversal of the external chest wall allows drainage of venous return of the upper extremities through the intercostal veins

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Fig. 10: Shoulder to chest wall Flow reversal of the external chest wall through the intercostal veins and into the azygos venous system

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Fig. 11: Collateral flow through muscular and superficial veins around the shoulder and scapula

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Imaging findings OR Procedure details

In modern times, most patients with chest wall varicose veins will have a history of central venous catheters (CVC). The subclavian vein, once the preferred site for CVC placement, has now been disregarded due to its high incidence of central venous stenosis as a medium to long-term complication.

Most patients will develop collateral venous drainage through the muscular veins in the base of the neck and scapula to either the external or internal jugular veins, most times ipsilaterally but sometimes contralaterally (Fig 12). The lateral thoracic vein also allows venous drainage to occur (Fig 13 and 14) as it connects either to the intercostal veins or to the venous network of the abdominal wall.

The diagnosis in these patients usually is reached after venography for the study of vascular access failure or increased pressure on hemodialysis machines.

On some occasions, the initial finding might be subtle, as in the case of patient depicted in Fig 15 and 16. An dilated opacified vessel cursing through the lateral chest wall on a chest CT for an unrelated matter, justified extending the CT scan to the upper abdomen, were an unknown vascular mass was identified (the patient assumed she was growing fat).

This vascular lesion was further studied by angiography were it was proven to be fed by the last three intercostal arteries (Fig 17 and 18), with a rather large nidus and venous drainage both through the chest wall into the subclavian vein (Fig 20) and through the abdominal wall into the femoral vein (Fig 19).

Sometimes, what is really a common manifestation of a central venous stenosis in a patient with a history of CVC placement can still be confusing. In a patient with a long forgotten temporary CVC placed years ago in a foreign country, symptoms of visual field defects and balance disorder attributed to the inner ear had motivated consultation from both ophthalmology and otorhinolaryngology specialists. His rather large body habitus probably explains why upper limb, ipsilateral neck and hemiface swelling went unnoticed. Furthermore, a first echodoppler evaluation of the vessels of the neck describing a normal appearing carotid artery and internal jugular vein seemed, at first, to exclude a vascular etiology for the symptoms.

The patient was referred to the Interventional Radiology unit of our institution for evaluation on an unrelated matter and a second Doppler scan confirmed antegrade venous flow with normal velocities along the internal jugular vein, but a high velocity flow reversal along the external jugular vein, which by now was quite prominent (Fig 23 and 24). CT scan confirmed large varicos veins cursing thru the lateral chest wall but no angioCT was performed due to the patient being allergic to iodinated contrast media.
A venography performed after completing a desensibilization protocol confirmed a tight venous stenosis of the subclavian vein, between the confluence of the internal and the external jugular veins and a short occlusion of the brachiocephalic vein (Fig. 25, 26 and 27). Notice that the ipsilateral internal jugular vein opacifies with a significant delay (Fig. 26) as the contrast agent has to travel upwards the external jugular vein and communicate with the internal jugular vein at the level of the mandible.

A covered stent was placed with clinical success.
Fig. 12: Patient on hemodialysis with a central venous cateter on the left subclavicular vein. Venous stenosis on the subclavian vein induces the venous blood flow from the upper limb to divert through the ipsilateral neck.

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**Fig. 13:** Subtle stenosis on the right subclavian vein. Notice the venous collaterals through muscle vein the the scapula and ipsilateral neck. Also notice the venous drainage through the lateral thoracic vein along the lateral chest wall

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**Fig. 14:** The same patient, at a bit latter time, notice that the neck venous collateral have cleared but the chest wall collaterals are seen.

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Fig. 15: A patient scanned for unconfirmed suspicion of pulmonary thromboembolism. A dilated opacified vein on the lateral chest wall was noticed.

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**Fig. 16:** The same patient, at the level of the upper abdomen, a vascular mass was noticed on the lateral wall.

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Fig. 17: Aortogram showing dilated intercostal arteries (last 3 on the left) with opacification of an amorphus image on the lower lateral chest wall.

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Fig. 18: The same patient at a little latter time, showing filling of a vascular lesion on the lower chest wall

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Fig. 19: This vascular lesion drained to the venous network around the femoral vein.

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Fig. 20: And also to the left subclavian artery through the lateral thoracic vein.

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Fig. 21: Patient first evaluated by an opthalmologist for visual field defects and retinal congestion, sent to an ENT specialist for observation. Eventually it came to the CT room for evaluation of left upper limb and ipsilateral neck and hemiface swelling. On the CT scan (without contrast due to allergy to iodinated contrast agents) marked venous dilation of the lateral chest wall, with soft tissue abnormalities.

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Fig. 22: The same patient, showing opacified veins along the lower left chest wall

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Fig. 23: Stenotic lesion of the left subclavian vein

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**Fig. 24:** Flow reversal with high velocities on the ipsilateral external jugular vein

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Fig. 25: At venography, a severe venous stenosis in the subclavian vein, between the internal and the external jugular vein confluence was shown, and marked retrograde flow along the left external jugular vein allowed venous drainage of the upper limb.

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Fig. 26: The internal jugular vein was shown to opacify with a significant delay

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Fig. 27: After angioplasty of this first stenosis, an short occluded segment of the brachiocephalic vein was also identified and subsequently deployed a covered stent. 6 months after, instent restonosis lead to recurrence of the symptoms.

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Conclusion

The complex venous anatomy and how it is able to adapt to changes explains the variable expression of venous pathology. A broader view of the possible venous draining pathways is essential to understand local changes in the chest wall.

High clinical suspicion is required and should be kept in mind when suggesting further imaging evaluation. Above all, the radiologist should embrace its central role in multidisciplinary patient care and never lose sight of the bigger picture.
References

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