A Woman Post Scalenectomy and First-Rib Resection With Dilated Vertebral Venous Plexus and a Facial Rash

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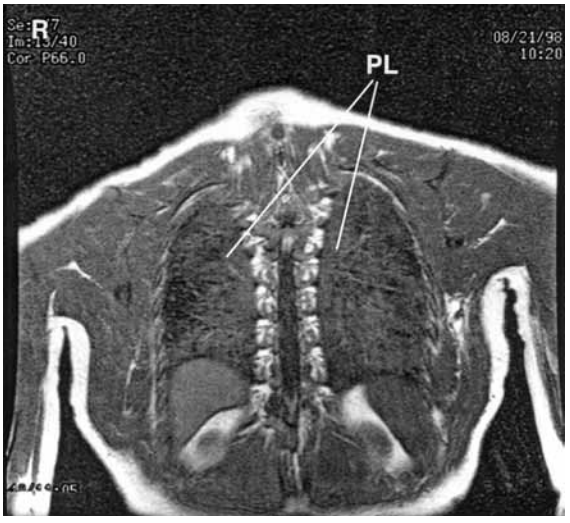
INTRODUCTION

A patient post bilateral scalenectomy and first-rib resections with right subclavian artery graft anastomosis with dilated vertebral venous plexus was selected for this presentation. All magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), and magnetic resonance venography (MRV) sequences were cross-referenced in order to arrive at an accurate diagnosis. Since it is not possible to present all of the acquired images, the images selected for this presentation were annotated and best display the pathologic changes that occur in costoclavicular compression of the draining veins of the brachial plexus.[1,2]

CLINICAL HISTORY

The patient was a 36-year-old righthand female with a complicated history that dated back to when she suffered a stroke secondary to trauma to the left carotid artery from a baseball injury to her left neck. She developed a "cyst" next to the pituitary gland, which was drained. Thereafter, she developed left-sided weakness and arm and leg pain. It was unclear as to the etiology of this process given that the stroke had been in the left hemisphere. Symptoms worsened, and the diagnosis of thoracic outlet syndrome (TOS) was suggested. Physical therapy and acupuncture were without relief. She underwent left scalenectomy and first-rib resection with some relief and elimination of double vision. Horner's syndrome developed as a complication. One year later, she developed right arm heaviness and posterior headaches, after which a diagnosis of right TOS was made without confirmation by MRI imaging. After conservative management, she underwent a partial right first-rib resection and anterior scalenectomy without relief; headaches worsened with numbness of the right upper extremity, and she had inability to lift her right upper extremity. She was also diagnosed with a cervical rib and Raynaud-type symptoms in the right hand and underwent surgery complicated by oversewing of the right subclavian artery. She developed severe right upper extremity pain and had a posterior scalenectomy. Six months later, she had a right carotid axillary artery bypass with saphenous vein graft. Symptoms worsened with generalized edema—all 4 extremities, including the face. She developed severe right periorbital edema and shortness of breath with minimal exertion and occasionally at rest. She was given controlled-release morphine sulfate for generalized pain. Ultrasound demonstrated pericardial thickening and/or fibrosis. Heart catheterization demonstrated increased

Figure 1. Drooping right shoulder and bilateral pleural effusions (PL) on the dependent posterior surface of the thorax

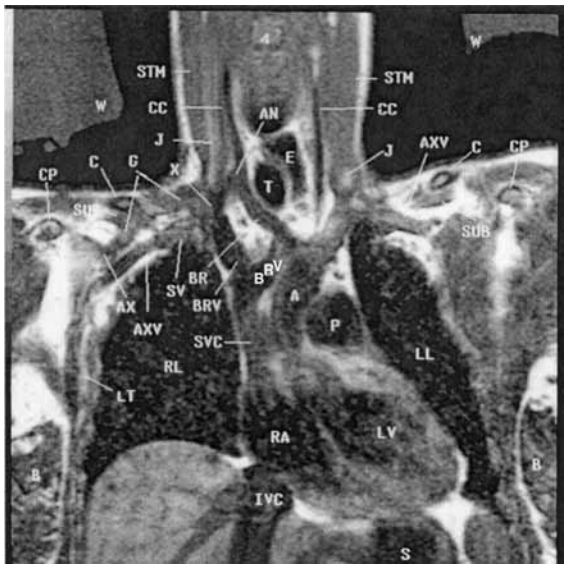


venous pressures and 60% stenosis of the right internal jugular vein. She had severe postprandial pain and weight loss. She developed lesions over the right side of her face that were under treatment by a dermatologist. Some of the lesions appeared to arise as bulla and eventually dried out, forming a scab with some degree of scarring of her dermis. Since the requesting neurologist suspected the clinical diagnosis of TOS, bilateral MRI/MRA/MRV of the brachial plexus was requested to display the landmark anatomy that altered the blood supply to and from the brachial plexus.

PHYSICAL EXAMINATION

The patient appeared as a well-developed female with some lesions over her right face and neck. The neck displayed some scars at the base of the neck from various procedures. Vital signs were as follows: blood pressure in the right arm, 110/80 mm Hg; pulse, 80 beats/min; temperature, 36.4ºC; weight, 61.4 kg; carotid pulses were palpable bilaterally; the right carotid artery had an early systolic bruit. Bruits were not detected on abduction external rotation of the upper extremities: radial pulses were preserved. Collateral venous distension was detected in the anterior chest and right neck; there was no periorbital edema. A winged scapula was detected on the left and slightly on the right. She had a "rash" over the right face that was scheduled for biopsy. A review of a postoperative arteriogram displayed a patent carotid axillary vein bypass. There was slight dilatation distal to the anastomosis. The left internal carotid artery was not visible. A duplex scan showed patency with normal flow velocities of the left internal carotid artery, as if she had a dissection, that appeared to have healed.

Figure 2. Drooping of the right shoulder, subclavian and axillary artery graft, intermediate high signal intensities within the bulbous dilated internal jugular veins, intermediate high signal intensity left external jugular vein (not labeled), intermediate high signal intensity within the left brachiocephalic vein (not labeled), and the graft anastomosis to the right common carotid artery

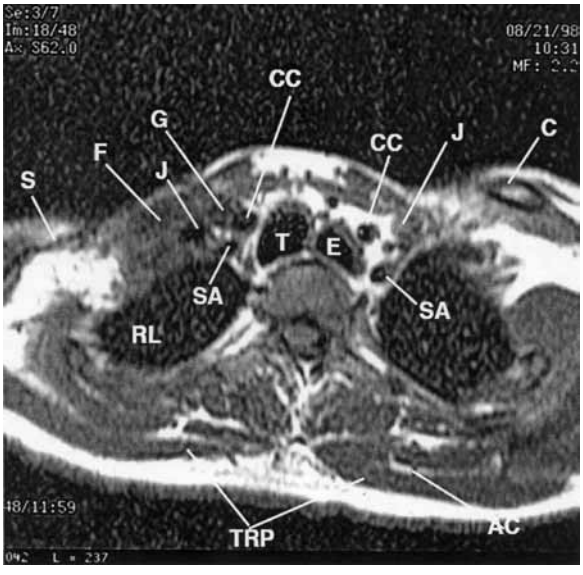


Observe stenosis of the right internal jugular vein (X). 4 indicates 4th cervical vertebra; A, aorta; AN, graft anastomosis; AX, axillary artery; AXV, axillary vein; B, breast; BR, brachiocephalic artery; BRV, brachiocephalic vein; C, clavicle; CC, common carotid artery; CP, coracoid process; E, esophagus; G, graft; IVC, inferior vena cava; J, jugular vein; LL, left lung; LT, long thoracic nerve; LV, left ventricle; RA, right atrium; RL, left lung; STM, sternocleidomastoid muscle; SUB, subclavius muscle; SVC, superior vena cava; T, trachea; W, saline water bags; X, right internal jugular vein.

METHODS AND MATERIALS

Plain chest radiographs (posterior-anterior and lateral) were not obtained prior to the MRI secondary to extreme pain. However, the procedure was discussed and the patient examined. Respiratory gating was controlled by the anesthesiologist throughout the procedure to minimize motion artifact. The patient was in supine position in a body coil, arms down to the side, and imaging was monitored at the MRI station. Magnetic resonance images were obtained on the 1.5 Tesla GE Signa XL MR scanner (GE Medical Systems, Milwaukee, Wisconsin). A body coil was used and no intravenous contrast agents were administered. A saline water bag was placed on the right and the left side of the neck to increase signal to

Figure 3. Fibrosis and scaring of the right neck and supraclavicular fossa, graft adjacent to the dilated common carotid artery, atrophy of the right shoulder, dilated trachea, and esophagus



Observe the gray proton-dense small left internal jugular vein (J). AC indicates spinal accessory nerve; C, clavicle; CC, common carotid artery; E, esophagus; F, fibrosis; J, jugular vein; RL, right lung; SA, subclavian artery; T, trachea, TRP, trapezius muscle.

noise ratio for high-resolution imaging. A full field of view (44 cm) of the neck and the thorax was used to image both supraclavicular fossae. Contiguous (4 mm) coronal, transverse (axial), oblique transverse, sagittal, and abduction external rotation (of the upper extremities) T1-weighted images and 2-dimensional time-of-flight (2D TOF) MRA/MRV were obtained. If there was clinical evidence of scarring, tumor and/or lymphatic obstruction, fast-spin echo T2-weighted images would have been selectively obtained. The parameters for acquiring each sequence have been published. The 2D TOF MRA and MRV sequence images included the venous sinuses.

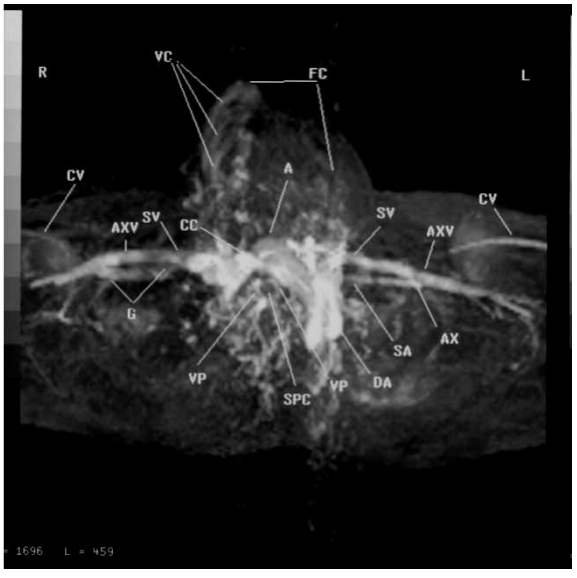
MRI FINDINGS

Multiplanar MRI displayed drooping of the right shoulder and bilateral pleural effusions on the dependent posterior surface of the thorax (Figure 1), graft anastomosis and stenosis of the right internal jugular vein (Figure 2), fibrosis and scaring of the right neck and supraclavicular fossa, and the graft adjacent to the dilated right common carotid artery and atrophy of the right shoulder (Figure 3). The stacked image of the 2D TOF displayed marginating collateral venous drainage over the right neck, face, and the spinal cord (Figure 4). The coronal 2D TOF 3D-reconstructed MRA and MRV images displayed high signal intensity venous stasis within the left subclavian vein, diminished signal intensity of decreased venous return within the small left internal jugular vein, irregular right subclavian-axillary artery graft reflecting fibrosis, graft anastomosis compressing the right internal jugular vein, dilated venous plexus marginating the spinal cord, and the wide separation of the gray proton-dense diminished arterial flow in the right subclavian artery graft (Figure 5). The left sagittal 3D-reconstructed image of the 2D TOF MRA and MRV confirmed the vertebral venous plexus marginating the spinal cord and motion artifacts secondary to general anesthesia (Figure 6).[3,4]

MRI Conclusions

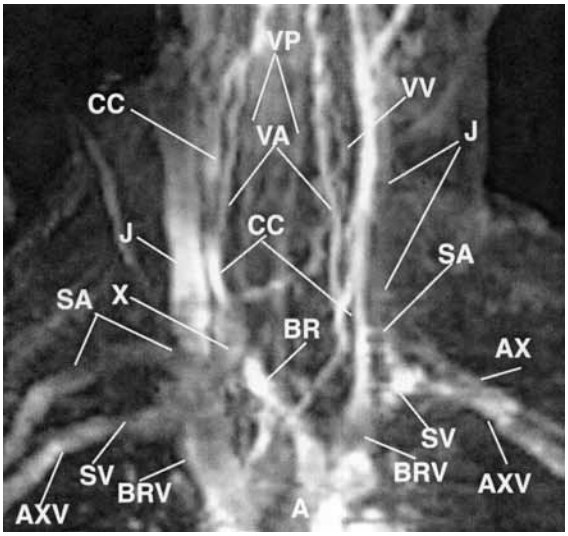
- Scarring of the mediastinum and scalene triangles;
- Stenosis right internal jugular vein;
- Increased collateral blood over the right neck and face responsible for "rash-like" changes above;
- Lymphedema secondary to scarring and fibrosis of

Figure 4. Ascending and descending aorta marginated by collateral veins that also displays the collateral venous drainage over the right neck and face, vertebral plexus marginating the spinal cord, dilated right and left axillary veins, decreased venous return to the graft, collateral venous return within the right and left cephalic veins, decreased venous return within the right subclavian vein as impedance to venous return within the left subclavian vein, and the dilated right common carotid artery



Facial vein (FC) collaterals, reciprocal dilated right axillary artery as compared to the left (AX). A indicates ascending aorta; AX, axillary artery; AXV, axillary vein; C, clavicle; CC, common carotid artery; CV, cephalic vein; DA, descending aorta; FC, facial vein; G, graft; SA, subclavian artery; SPC, spinal cord; SV, subclavian vein; VP, vertebral plexus.

Figure 5. Dilated high signal intensity venous stasis within the left subclavian vein, diminished signal intensity of decreased venous return within the small left internal jugular vein, irregular right subclavian-axillary artery graft reflecting fibrosis, graft anastomosis compressing the right internal jugular vein, dilated venous plexus marginating the spinal cord



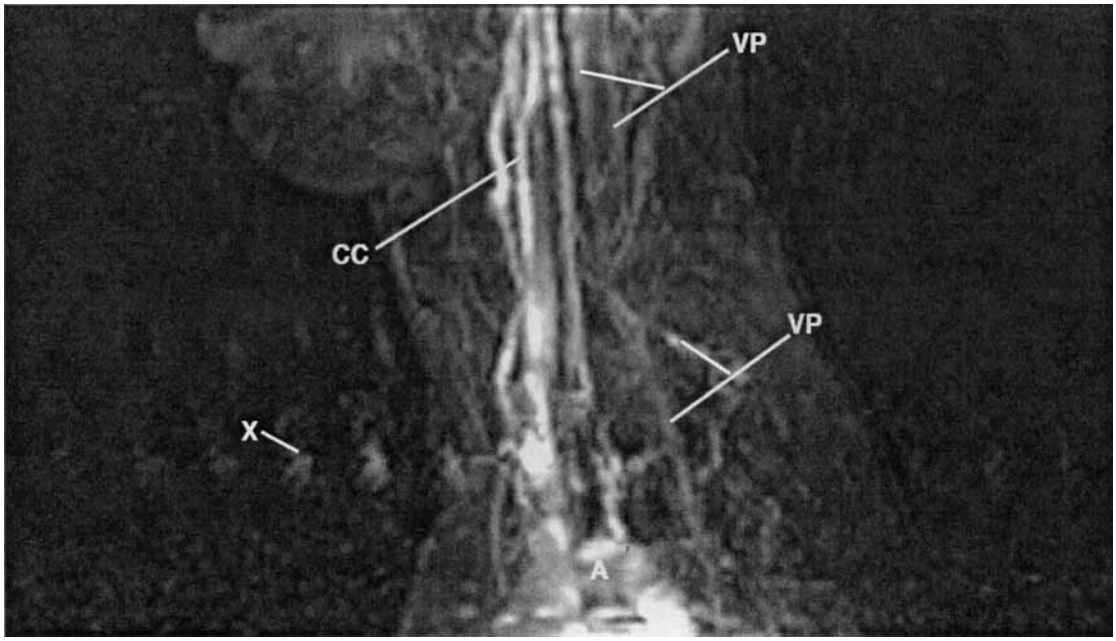
Observe the high signal intensity of the brachiocephalic artery proximal to the anastomosis as well as the wide separation of the gray proton-dense diminished arterial flow in the subclavian artery graft. A indicates aorta; AX, axillary artery; AXV, axillary vein, BR, brachiocephalic artery; BRV, brachiocephalic vein; CC, common carotid artery; J, jugular vein; SA, subclavian artery graft; SV, subclavian vein; VA, verterbral artery; VP, venous plexus; VV, vertebral vein; X, anastomosis.

the thoracic lymph ducts;
- Right chest wall atrophy;
- Venous stasis right and left neck, contributing to headaches and neck pain.

DISCUSSION

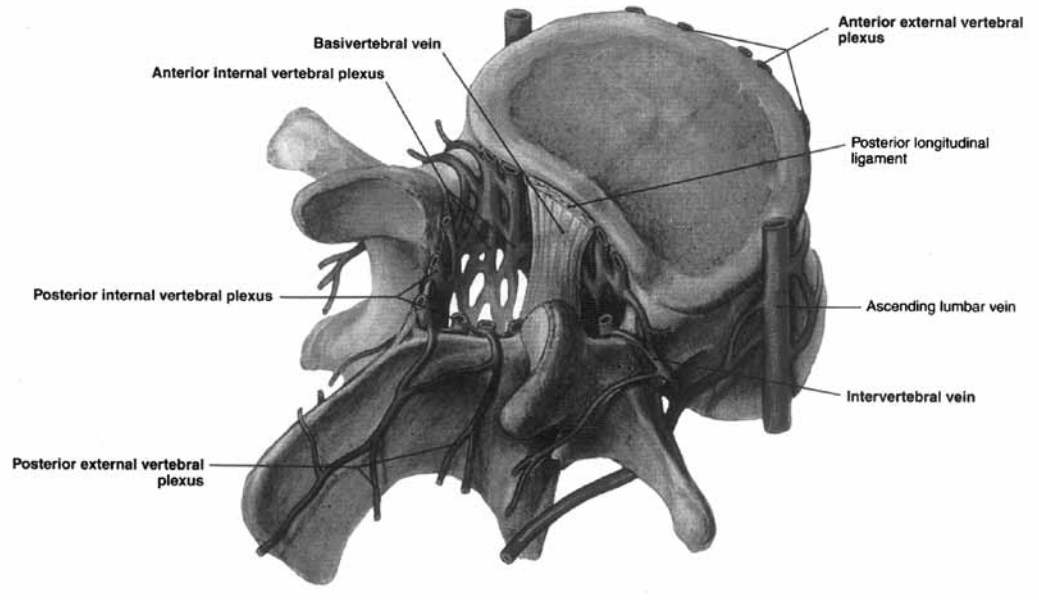
Vertebral venous plexus is an extensive paravertebral system of valveless venous channels within and alongside the spinal column. The plexus provides direct venous

Figure 6. Venous plexus marginating the spinal cord, common carotid artery, aorta, and the motion artifact secondary to general anesthesia



A indicates aorta; CC, common carotid artery; VP, venous plexus; X, motion artifact.

Figure 7. Vertebral plexus with the veins of the vertebral column



The veins drain blood from the vertebrae, and the contents of the spinal canal form plexuses that extend the entire length of the spinal column (Batson's veins). The plexuses are grouped according to whether they lie external to or within the vertebral canal. They are the internal vertebral, external vertebral, basivertebral, intervertebral, and veins of the spinal cord. The basivertebral veins drain the bodies of vertebrae and may flow into the anterior external or anterior internal vertebral plexuses. Image from Clemente CD, *Anatomy, An Atlas of the Human Body*, 5th ed, 2007.

communication from the peritoneum and lower body to the cranial cavity and spinal canal.[5,6] Obstruction to venous return increases intracranial, intrathoracic, and intra-abdominal pressure. In migraine and TOS patients, bicuspid valve compression (costoclavicular) within the veins of the neck and supraclavicular fossae and neurovascular bundles causes increased collateral venous and lymphatic return, expands fascial planes, and triggers complaints of upper extremity numbness and tingling pain, temperature and color changes, visual blurring and floaters, and headache. Obstruction to venous return also causes dilatation of the vertebral venous plexus (Batson's) and less-recognized symptoms of TOS such as: neck pain; hip, groin, and low back pain; radicular pain in the legs and feet, reflecting the proximity of the dilated plexus to the discs and spinal nerve roots.[6]

Abduction external rotation of the upper extremities enhances TOS symptoms and migraine.

TAKE-HOME MESSAGE

Knowledge of normal surface and landmark anatomy is important for interpretation of MRI, MRA, and MRV studies in patients with brachial plexopathy. Costoclavicular compression of the draining veins of the neck, supraclavicular fossae with lymphatics diverts venous return into the vertebral venous plexuses with the lymphatics. This, in turn, expands fascial planes that trigger patient complaint. In our patient, the dilated venous plexuses reflected diverted venous return marginating the spinal cord. The facial "rash" reflected dilated veins from obstructed venous return as displayed on the 2D TOF MRA and MRV (Figures 6 and 7).

Since dilatation of the vertebral venous plexus (Batson's) compresses the long tracts of the spinal cord, it is reasonable to believe that piriformis syndrome reflects dilatation of the Batson's plexus.

ACKNOWLEDGEMENTS

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