Effects of radiation and MediPort placement on the development of thoracic outlet syndrome

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ABSTRACT

We present a patient who exemplifies the interplay of factors contributing to the development of venous-type thoracic outlet syndrome. The patient was treated with both radiation and chemotherapy for squamous cell carcinoma in the head and neck region; radiation and chemotherapy have been known to damage the vascular system. Multimodality treatment is necessary to achieve good long-term results in these complex patients.

KEYWORDS First rib resection and scalenectomy; MediPort; thoracic outlet syndrome

There are several different causes of thoracic outlet syndrome (TOS), all of which involve the compression of the thoracic outlet. We report a case of venous-type TOS.

CASE REPORT

A 48-year-old man presented in April 2018 with swelling in his neck, right arm, and right upper chest. He had a history of squamous cell carcinoma at the base of the tongue, treated by radiation (5000 rad in supraclavicular region) and chemotherapy by a right internal jugular MediPort. His cancer had been in remission since July 2017. In September 2017, he was admitted for pain and swelling in his right neck and was diagnosed with staphylococcal infection and sepsis, after which the port was removed. He was noted to have thrombosis of his right internal jugular, axillary, and subclavian veins. Lovenox was started. He continued to experience pain and swelling. A vascular surgery consultation confirmed these findings and advised a right arm venogram.

A venogram of the right subclavian vein disclosed chronic, complete occlusion (*Figure 1a*). Angioplasty showed significant waisting of the balloon at the costoclavicular junction indicating external compression consistent with venous TOS. The final result was a 20% diameter stenosis of the right subclavian vein. A right transaxillary first rib resection was performed in May 2018. There was evidence of

radiation-induced fibrosis of the subcutaneous tissues. A right upper-extremity venogram demonstrated complete occlusion of the right subclavian and innominate vein (*Figure 1b*). After traversing the lesion, serial dilation was performed, which led to a residual stenosis of 4 mm in maximum diameter. An 8-mm cutting balloon was then used at the residual stenosis, and a venogram showed a focal dissection vs extravasation of the subclavian vein. We performed stent-assisted angioplasty with an 11 × 59 mm VBX stent (balloon expandable, covered stent) and then a subsequent 11 × 39 VBX stent. VBX stents were placed because the thoracic outlet was decompressed and the proximal and distal landing zones were large in diameter. We had an excellent angiographic result (*Figure 1c, 1d*). The patient recovered well and was discharged home on the second postoperative day on aspirin, clopidogrel, and dabigatran.

DISCUSSION

TOS occurs when nerves or blood vessels are compressed by the ribs, clavicle, or neck muscles in the thoracic outlet.¹ There are three different types of TOS: neurogenic, venous, and arterial.¹ Venous TOS occurs in 5% of cases.¹ Venous thrombosis of the axillosubclavian vein may occur, leading to upper-extremity swelling and pain.

The diagnosis of venous TOS is often challenging. The most common imaging study is a venous duplex ultrasound,

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Figure 1. Right axillosubclavian vein (a) before, (b) during, and (c, d) after balloon angioplasty and stent placement.

which has a specificity of 82% to 100% and a sensitivity of 78% to 100%.² The diagnosis of venous TOS requires evidence of thrombosis of the subclavian vein with a loss of flow.² After a duplex ultrasound, a contrast venography is performed.²

Venous TOS has historically been treated with anticoagulation and symptomatic relief.² Anticoagulation has a significant rate of disability, recurrent thrombosis, and persistent symptoms.² Symptomatic treatment involves pain control and compression, both of which are ineffective.² In the 1970s, catheter-directed thrombolysis became available and was considered effective if used within 14 days of symptom onset.² Thrombolysis is not a definitive treatment, as patients often redevelop thrombosis.² First rib resection and scalenectomy has been advocated to completely decompress the thoracic outlet.² There are several approaches to this procedure, including supraclavicular and transaxillary approaches.² In this patient, the transaxillary approach was used to provide maximal exposure to the anterior portion of the first rib.² After decompression, a venolysis and open or percutaneous

venoplasty are often done to improve outflow.² Patients are discharged on anticoagulation for 3 to 6 months.²

This patient's history of squamous cell carcinoma of the tongue with subsequent chemoradiation made this case intriguing. The patient had a right internal jugular vein MediPort. Deposition of fibrin on the thrombogenic catheter surface and the following in-growth of smooth muscle and endothelial cells takes place on all catheters and begins shortly after placement.³ The catheter traversed the right internal jugular vein past the junction with the subclavian vein and could have contributed to thrombus formation at the proximal extent of the subclavian vein.

Radiation has been associated with the vasculopathic deterioration of vessels.^{4,5} In the early inflammatory phase, endothelial cell swelling and sloughing characterize radiation-induced damage. In the later phases, endothelial cell and smooth muscle cell proliferation contribute to vessel stenosis and thrombosis.⁵ Radiation could have contributed to the right subclavian vein occlusion. Radiation-induced fibrosis of the subcutaneous tissues surrounding the first rib significantly increased the difficulty of the operation.

In summary, long-term satisfactory results in venous-type TOS patients are achieved by removal of external compression and restoration of luminal flow. In this patient, the interplay of many factors contributed to the development of venous-type TOS. Multimodality treatment, including surgical first rib resection and percutaneous venous reconstruction, was necessary to achieve satisfactory results.

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1. John Hopkins Medicine. Thoracic outlet syndrome. https://www.hopkinsmedicine.org/healthlibrary/conditions/cardiovascular_diseases/thoracic_outlet_syndrome_22,ThoracicOutletSyndrome. Accessed February 5, 2020.
2. Moore R, Lum YW. Venous thoracic outlet syndrome. *Vascular Med*. 2015;20:182–189. doi:10.1177/1358863X14568704.
3. Forauer AR, Theoharis CG, Dasika NL. Jugular vein catheter placement: histologic features and development of catheter-related (fibrin) sheaths in a swine model. *Radiology*. 2006;240(2):427–434. doi:10.1148/radiol.2402031129.
4. Weintraub NL, Jones WK, Manka D. Understanding radiation-induced vascular disease. *J Am Coll Cardiol*. 2010;55(12):1237–1239. doi:10.1016/j.jacc.2009.11.053.
5. Halle M, Gabrielsen A, Paulsson-Berne G, et al. Sustained inflammation due to nuclear factor-kappa B activation in irradiated human arteries. *J Am Coll Cardiol*. 2010;55(12):1227–1236. doi:10.1016/j.jacc.2009.10.047.