

Deep Vein Thrombosis of the Subclavian Vein in a College Volleyball Player

Sidney Dane Treat,^{*†} MD, Patrick A. Smith,[‡] MD, Dennis Y. Wen,[§] MD, and James J. Kinderknecht,[§] MD

From [†]Olmsted Medical Center, Rochester, Minnesota, [‡]Columbia Orthopedic Group, Columbia, Missouri, and [§]University of Missouri-Columbia, Columbia, Missouri

Keywords: Paget-Schroetter syndrome; deep vein thrombosis; DVT; athletes; blood vessels; blood clot

Paget-Schroetter syndrome (PSS) refers to axillosubclavian deep vein thrombosis (DVT) without secondary cause. It is frequently referred to as effort-induced thrombosis and is exclusive of DVT cases with clear causes such as postsurgical immobilization, smoking, polycythemia, and cancer. PSS is most common in 10- to 35-year-olds, has been reported more frequently in men, and usually occurs in the dominant upper extremity.¹³ The syndrome often occurs following an activity involving repetitive abduction and external rotation of the involved extremity, such as throwing or weightlifting; however, there may be no history of obvious antecedent trauma. Although 80% of PSS cases are associated with thoracic outlet syndrome,^{1,6,13} only 1% to 12% of patients with thoracic outlet syndrome have complaints consistent with PSS.^{1,6,13}

CASE

A 21-year-old female, right-hand dominant, college volleyball outside hitter presented following a match with complaints of swelling, tightness, heaviness, and aching of her right arm. She noticed mild symptoms during warm-ups, then had increasing symptoms early in the match and was unable to continue play. She denied shortness of breath, chest pain, or any history of trauma to her right arm and was otherwise healthy. She denied personal or family history of hematological disorders and denied smoking or illicit drug use. Her only medication was an oral contraceptive. On examination, the patient had full range of motion of her right arm and shoulder, and resistance testing revealed full and symmetric strength. There was, however, definite swelling of the entire right arm. The veins in her right fore-

arm and hand were more prominent than those of the left arm and did not recede with elevation of the extremity above the level of the heart. Distal radial pulses were full and equal bilaterally without delay, and she was neurologically intact. A Doppler scan of her right upper extremity was read as normal.

The next morning, the patient's symptoms were only mildly decreased, and the physical exam was unchanged. The circumference of the right arm was approximately 2 cm greater than the left, from the proximal arm to the distal forearm. Compartments of the forearm and upper arm were soft and nontender. An Adson's maneuver obliterated the radial pulse on the right side but not on the left. The patient underwent a right upper-extremity venogram that showed an extensive thrombus with complete occlusion from the right axillary vein extending into the subclavian vein. Significant collateralization was also noted (Figure 1).

The patient was admitted to the ICU and started on heparin anticoagulation and t-PA thrombolytic therapy.

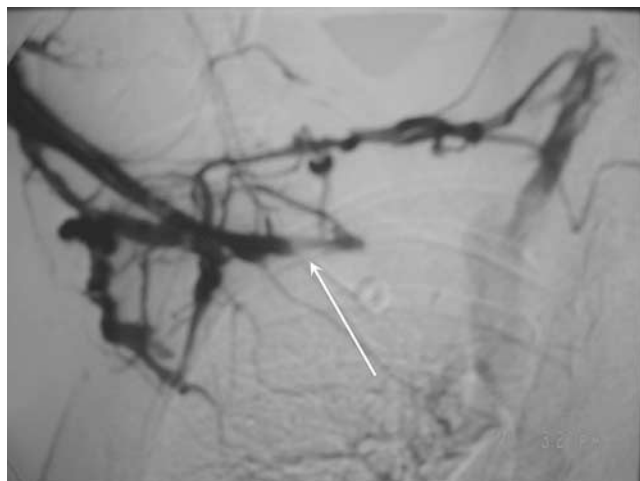


Figure 1. Prethrombolysis venogram showing complete occlusion of the axillosubclavian vein and significant collateralization.

*Address correspondence to Sidney Dane Treat, University of Missouri-Columbia, Olmsted Medical Center, 210 Ninth Street SE, Rochester, MN 55904 (e-mail:danethebronco@yahoo.com).



Figure 2. Post-thrombolysis venogram showing improvement of flow through the axillary vein, residual occlusion of the subclavian vein, and persistence of collateral blood flow.

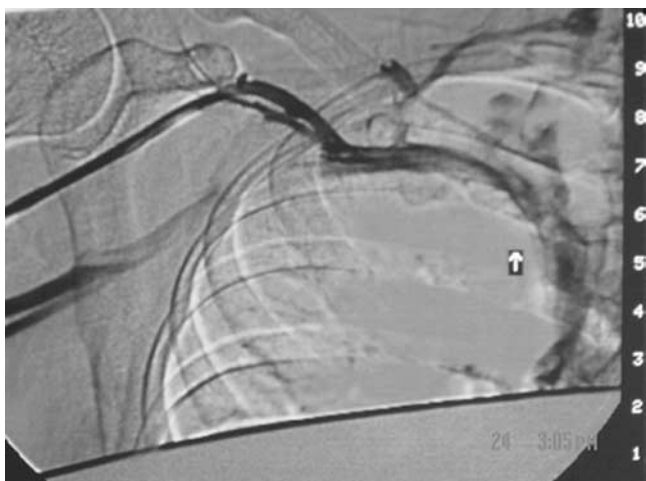


Figure 3. Postsurgical venogram showing patency through the axillosubclavian vein and significant decrease in collateral blood flow.

Thrombolysis was assessed with serial venograms every 6 to 12 hours. After infusion of t-PA for approximately 12 hours, there was evidence of significant lysis of the axillary thrombosis, but the subclavian vein remained occluded (Figure 2). After 12 additional hours of t-PA infusion and little further success of clot lysis, the process was augmented with mechanical thrombolysis via balloon venoplasty of the subclavian vein. However, the lumen immediately collapsed and reoccluded after several attempts. The thrombolytic therapy was discontinued, and the patient was converted to coumadin.

A CT scan of the chest showed extrinsic compression of the residual subclavian lumen. A final venogram revealed positional occlusion of her collaterals with the right arm abducted and externally rotated. She completed 6 weeks of outpatient anticoagulation and then underwent elective thoracic outlet decompressive surgery with removal of the

first rib and resection of both the anterior and middle scalenes through a supraclavicular approach. A postoperative venogram showed residual occlusion, and again balloon venoplasty was performed. The procedure successfully reestablished patency of her subclavian vein and subsequently decreased flow through her collaterals (Figure 3). Her postsurgical course was uneventful. The patient continued coumadin 3 months postoperatively and underwent several months of rehabilitation. Six months after surgery, a repeat venogram showed normal flow through the axillo-subclavian vein with no residual thrombosis or compression. She played the next season without restrictions or complaints.

DISCUSSION

Presentation

Patients presenting with PSS will usually give a history of repetitive or strenuous activity involving the affected extremity prior to the onset of symptoms. These include pain or aching, swelling, fatigue and heaviness of the extremity, and rarely numbness of the hand or fingers. Symptoms will worsen with activity and improve with rest. Swelling, cyanosis, and prominence of superficial veins may be noted on exam. Pulses are typically normal and symmetric, although the Adson, Wright, and costoclavicular maneuvers can alter the quality of the pulse in the affected arm.

Although it is inconsistently defined in the literature, we perform the Adson's maneuver by passively placing the patient's arm in a position of 90° abduction with external rotation, with the elbow flexed to 90° and the patient's head rotated toward the arm being tested. Wright's maneuver is identical except the head is rotated away from the tested side. Finally, we perform the costoclavicular maneuver by having the patient thrust his or shoulders downward and backward, as with an exaggerated military attention position. These 3 tests are more commonly associated with thoracic outlet compression, and obliteration or diminishing of the radial pulse while performing any of the maneuvers would be considered positive for compression. Positive results are more significant if the unaffected arm tests negative.

The typical history and physical exam in a patient leads to a fairly narrow differential diagnosis. Other diagnoses that may be considered include compartment syndrome, cervical radiculopathies and brachial plexopathies, arterial or neurogenic thoracic outlet compression, shoulder pathology including instability, and peripheral nerve entrapment syndromes.

Although volleyball has occasionally been mentioned as a cause of PSS,^{2,4,17,19} we found no case documenting the occurrence of PSS in a female volleyball player. PSS has been associated with baseball, football, gymnastics, tennis, swimming, weightlifting, volleyball, handball, basketball, golf, softball, hockey, and rowing.^{2,4,17,19} PSS is widely regarded as probably the most common vascular problem in athletes.¹⁷

With recent advances in the treatment of DVT and growing understanding of the pathophysiology of PSS, improvements and consensus in many aspects of its treatment have emerged. Most physicians advocate early diagnosis and treatment with thrombolytics and anticoagulants followed by surgery for those with residual symptomatic lesions.¹⁶ However, controversy still surrounds the indications for, timing of, and technical approaches of surgical intervention.¹⁶ Lack of consensus surrounds the utility of Doppler ultrasound in the evaluation of PSS as well. Unlike the surgical issues, Doppler is rarely addressed, much less debated, but is especially important for physicians who initially see patients presenting with PSS.

Doppler Ultrasonography Versus Venography

Doppler studies evaluating suspected PSS often result in false-negative results, as in the case presented here. Few articles on PSS address the issue. Machleder considered venography essential in a study published in 1993.¹² He cited studies by Haire et al that concluded ultrasound scanning was inaccurate for evaluation of suspected retroclavicular thromboses.^{7,8} However, Doppler studies are performed initially more times than not despite the fact that no reliable estimates exist for sensitivity, specificity, or false-negative rates. In several studies employing ultrasound, venography was performed whether Doppler was positive or negative.^{1-3,11,12,18} This seemingly renders ultrasound redundant and irrelevant.

Doppler studies have limited use in the evaluation of suspected PSS, for several reasons. First, the initial clinical presentation of acute PSS is often specific enough to elicit a very limited differential. Clinical suspicions will often be sufficiently high so that a negative Doppler will only prompt the ordering of the more sensitive venogram. Second, as most treatment algorithms now begin with thrombolysis, a positive Doppler study will be followed by venipuncture, delivery of the thrombolytic agent, and serial venograms to assess progress. Third, collateralization increases the likelihood of a false-negative Doppler result.⁹ Last, unlike ultrasound, venograms can help determine the extent and degree of occlusiveness of the thrombus, identify and evaluate the collateral circulation, and suggest sites of external compression.¹⁵

Ultrasound is appropriate in the case of any contraindications to venography. Also, in regional referral centers with substantial experience with PSS, ultrasound may be more reliable, although no data are available. In the days or weeks following thrombolysis, ultrasound may be appropriate to assess for the presence of flow through either the axillosubclavian vein or collaterals.

In the setting of PSS, Doppler studies may at best delay thrombolysis and at worst lead physicians away from the correct diagnosis. Thrombolysis has consistently been shown to be more effective when performed earlier rather than later. According to 1 author, opinion now appears to

favor an attempt at thrombolysis up to 10 to 14 days after symptom onset.¹⁶

Surgery

Although most vascular surgeons agree that decompression of the thoracic outlet is generally beneficial in PSS, many still debate the timing, optimal approach, and absolute indications for this surgery. Several surgeons promote the prompt surgical decompression of the thoracic outlet following successful lysis.^{3,5,14,18} Others will delay surgery 4 to 6 weeks until venous inflammation resolves before proceeding with decompression.^{1,10,12} And still others will reevaluate the patient after 1 to 3 months of anticoagulation and primarily use patient symptomatology to help decide whether to proceed with surgical decompression.^{2,11}

Another point of contention is the surgical approach. Several surgeons promote an axillary approach,^{1,13,18} many others use a supraclavicular approach,^{2,3,11} whereas others may use infraclavicular¹⁴ or combinations of the above.³ Finally, although most surgeons will remove the first rib and anterior scalene muscle, some also remove the middle scalene,^{2,3,11,14} subclavius,¹⁴ or the costoclavicular ligament,¹⁸ as well as other structures found to have potential for compression at the time of surgery.

In 1996, Rutherford and Hurlbert surveyed 25 vascular surgeons with considerable experience in the treatment of PSS.¹⁶ In the event of successful lysis, 86% would proceed directly with thoracic outlet decompression, whereas 14% would withhold surgery until symptoms returned. Regarding timing of surgery, about one third would proceed with surgery acutely, whereas two thirds would delay surgery 1 to 3 months. This particular study did not address optimal incisional approaches.

Our patient underwent thoracic outlet decompression 6 weeks after her initial presentation. Surgery was recommended when post-thrombolytic venography revealed residual occlusion and extrinsic compression of the subclavian vein.

SUMMARY

We have presented the case of a female collegiate volleyball player with PSS. Salient points in her case include the negative Doppler, the surgical protocol followed, and her full recovery and return to play. Although the treatment of PSS has improved markedly with the introduction of thrombolytic therapy, the utility of Doppler studies and the exact details of optimal surgical indications, timing, and approaches have yet to be worked out. We feel that Doppler studies should be used with caution in evaluation of suspected PSS. We also feel that each surgical protocol may have equal efficacy in the hands of experienced surgeons. However, for the sports medicine physician responsible for the initial care of PSS, consensus or at least acknowledgment of the equivalence of different protocols would help alleviate doubt and aid in the decision-making process.

ACKNOWLEDGMENT

The authors would like to thank the following people who helped with editing and proofreading of the article: Dan Vinson, MD; Matt Thornburg, MD; Jessica Bailey, PhD; Mary Barile, BA; and Steven Zweig, MD.

REFERENCES

- Adelman MA, Stone DH, Riles TS, et al. A multidisciplinary approach to the treatment of Paget-Schroetter syndrome. *Ann Vasc Surg.* 1997;11:149-154.
- Arko FR, Harris EJ, Zarins CK, et al. Vascular complications in high-performance athletes. *J Vasc Surg.* 2001;33:935-942.
- Azaki A, McElhinney DB, Thompson RW, et al. Surgical management of subclavian-vein effort thrombosis as a result of thoracic outlet compression. *J Vasc Surg.* 1998;28:777-786.
- Baker CL Jr, Liu SH. Neurovascular injuries to the shoulder. *J Orthop Sports Phys Ther.* 1993;18:360-364.
- Druy EM, Trout HH III, Giordano JM, et al. Lytic therapy in the treatment of axillary and subclavian vein thrombosis. *J Vasc Surg.* 1985;2:821-827.
- Gloviczki P, Kazmier FJ, Hollier LH. Axillary-subclavian venous occlusion: the morbidity of a nonlethal disease. *J Vasc Surg.* 1986;4:333-337.
- Haire WD, Lynch TG, Lieberman RP, et al. Utility of duplex ultrasound in the diagnosis of asymptomatic catheter-induced subclavian vein thrombosis. *J Ultrasound Med.* 1991;10:493-496.
- Haire WD, Lynch TG, Lund GB, et al. Limitations of magnetic resonance imaging and ultrasound-directed (duplex) scanning in the diagnosis of subclavian vein thrombosis. *J Vascular Surg.* 1991;13:391-397.
- Horattas MC, Wright DJ, Fenton AH, et al. Changing concepts of deep venous thrombosis of the upper extremity: report of a series and review of the literature. *Surgery.* 1988;104:561-567.
- Kunkel JM, Machleder HI. Treatment of Paget-Schroetter syndrome: a staged, multidisciplinary approach. *Arch Surg.* 1989;124:1153-1157.
- Lee WA, Hill BB, Harris EJJ, et al. Surgical intervention is not required for all patients with subclavian vein thrombosis. *J Vasc Surg.* 2000;32:57-67.
- Machleder HI. Evaluation of a new treatment strategy for Paget-Schroetter syndrome: spontaneous thrombosis of the axillary-subclavian vein. *J Vasc Surg.* 1993;17:305-315.
- Machleder HI. Venous disorders. In: Machleder HI, ed. *Vascular Disorders of the Upper Extremity.* 2nd rev ed. Mount Kisco, NY: Futura Publishing; 1989:269-296.
- Molina JE. Surgery for effort thrombosis of the subclavian vein. *J Thorac Cardiovasc Surg.* 1992;103:341-346.
- Nemmers DW, Thorpe PE, Knibbe MA, et al. Upper extremity venous thrombosis: case report and literature review. *Orthop Rev.* 1990;19:164-172.
- Rutherford RB, Hurlbert SN. Primary subclavian-axillary vein thrombosis: consensus and commentary. *Cardiovasc Surg.* 1996;4:420-423.
- Sotta RP. Vascular problems in the proximal upper extremity. *Clin Sports Med.* 1990;9:379-388.
- Urschel HCJ, Razzuk MA. Neurovascular compression in the thoracic outlet: changing management over 50 years. *Ann Surg.* 1998;228:609-617.
- Zell L, Kindermann W, Marschall F, et al. Paget-Schroetter syndrome in sports activities: case study and literature review. *Angiology.* 2001;52:337-342.