Malignancy-related superior vena cava syndrome

AUTHORS: Reed E Drews, MD, Dmitry J Rabkin, MD, PhD
SECTION EDITORS: Eduardo Bruera, MD, John F Eidt, MD, Joseph L Mills, Sr, MD, Nestor L Muller, MD, PhD
DEPUTY EDITORS: Sadhna R Vora, MD, Kathryn A Collins, MD, PhD, FACS

All topics are updated as new evidence becomes available and our peer review process is complete.

Literature review current through: **Feb 2024.**
This topic last updated: **Mar 23, 2022.**

INTRODUCTION

Superior vena cava (SVC) syndrome results from any condition that leads to obstruction of blood flow through the SVC. Malignant obstruction can be caused by direct invasion of tumor into the SVC, or by external compression of the SVC by an adjacent pathologic process involving the right lung, lymph nodes, and other mediastinal structures, leading to stagnation of flow and thrombosis [1-3]. In some cases, both external compression and thrombosis coexist. In addition, patients with malignancy have a higher risk of venous thrombosis related to indwelling venous devices (eg, central venous catheter, pacemaker).

While direct invasion or external compression from tumor once accounted for the majority of cases of SVC syndrome in cancer patients, the overall incidence of device-related SVC syndrome has risen, largely because of increased use of intravascular devices, now accounting for 20 to 40 percent of cases [4].

This review will focus on the pathophysiology, etiology, clinical presentation, and diagnostic evaluation of SVC syndrome in patients with malignancy, and the treatment of malignant SVC syndrome. The management of central vein thrombosis in the setting of hemodialysis and other indwelling intravascular catheters is addressed elsewhere. (See "Malfunction of chronic hemodialysis catheters" and "Central vein obstruction associated with upper extremity hemodialysis access" and "Catheter-related upper extremity venous thrombosis in adults".)

PATHOPHYSIOLOGY

SVC obstruction, a type IV thoracic central venous obstruction (figure 1), related to malignancy results from extrinsic compression of the SVC by either the primary tumor or enlarged mediastinal lymph nodes, or as a result of direct tumor invasion of the SVC (image 1). (See "Clinical manifestations of lung cancer", section on 'Intrathoracic clinical manifestations'.)

Patients with malignancy also have a higher risk of venous thrombosis related to indwelling venous devices (eg, central venous catheter, pacemaker). Thrombosis related to central venous devices is reviewed separately. (See "Clinical features, diagnosis, and classification of thoracic central venous obstruction", section on 'Risk factors' and "Catheter-related upper extremity venous thrombosis in adults".)

As the flow of blood within the SVC becomes obstructed, venous collaterals form alternative pathways for the return of venous blood to the right atrium (figure 2). Collateral veins may arise from the azygos, internal mammary, lateral thoracic, paraspinous, and esophageal venous systems (image 2). The venous collaterals dilate over several weeks. As a result, upper body venous pressure is markedly elevated initially but decreases over time. However, even when well-developed collateral drainage patterns are present, central venous pressures remain elevated, producing the characteristic signs and symptoms of SVC syndrome. (See 'Clinical features' below and "Clinical features, diagnosis, and classification of thoracic central venous obstruction", section on 'Collateral venous patterning'.)

Patients with malignant disease may develop symptoms of SVC syndrome quickly because rapid tumor growth does not allow adequate time to develop collateral flow. By contrast, fibrosing mediastinitis due to an infection, such as histoplasmosis, as a cause of SVC occlusion may not become symptomatic for years. (See 'Differential diagnosis' below.)

Cardiac output may be diminished transiently by acute SVC obstruction, but within a few hours, blood return is reestablished by increased venous pressure and collaterals. Hemodynamic compromise, if present, more often results from mass effect on the heart than from SVC compression [5].

TYPICAL MALIGNANCIES

An intrathoracic malignancy is responsible for 60 to 85 percent of cases of SVC syndrome, and SVC obstruction is the presenting symptom of a previously undiagnosed tumor in up to 60 percent of these cases [4,6,7]. Non-small cell lung cancer (NSCLC) is the most common malignant cause of SVC syndrome, accounting for approximately 50 percent of all cases [4,6,8],

followed by small cell lung cancer (SCLC; approximately 25 to 35 percent of all cases) and non-Hodgkin lymphoma (NHL; 10 to 15 percent of cases). Together, it is estimated that lung cancer and NHL are responsible for approximately 95 percent of the cases of SVC syndrome that are caused by malignancy [4]. (See "Approach to the adult patient with a mediastinal mass".)

Lung cancer — Approximately 2 to 4 percent of patients with lung cancer develop SVC syndrome at some point during their disease course [9-11]. SVC syndrome is more common with SCLC, occurring in approximately 10 percent of cases at presentation [11-16]. This is presumably because SCLC develops and grows rapidly in central, rather than peripheral, airways. Fewer than 2 percent of patients presenting with NSCLC have SVC syndrome as a complication, but because of the higher incidence, NSCLC is a more frequent cause of SVC syndrome than is SCLC [11].

Lymphoma — SVC syndrome develops in 2 to 4 percent of cases of NHL [9,17]. For unclear reasons, Hodgkin lymphoma is rarely a cause of SVC syndrome, despite its common presentation with mediastinal lymphadenopathy [18]. (See "Clinical presentation and initial evaluation of non-Hodgkin lymphoma" and "Nodular lymphocyte-predominant Hodgkin lymphoma: Clinical manifestations, diagnosis, and staging".)

The incidence and pathogenesis of SVC vary in different NHL subtypes:

- Diffuse large cell and lymphoblastic lymphomas are the most common subtypes that are associated with SVC syndrome. In one series of 915 patients with NHL, 36 presented with SVC syndrome, and all but one had either the diffuse large cell or lymphoblastic subtype [17]. Among patients diagnosed with lymphoblastic (n = 56) or diffuse large cell lymphoma (n = 339), the incidence of SVC syndrome at presentation was 21 and 7 percent, respectively. The incidence in other subtypes was 0 to 3.9 percent.

- SVC syndrome is even more common in patients with primary mediastinal large B-cell lymphoma with sclerosis, an unusual and aggressive NHL subtype that represents 3 to 7 percent of all diffuse large cell lymphomas. Patients typically present with a rapidly enlarging anterior mediastinal mass, frequently with associated SVC syndrome. In one report of 30 patients, 17 (57 percent) had SVC syndrome at presentation [19]. In addition, other patients who did not meet the clinical criteria for SVC syndrome had radiologic evidence of compression of this vessel by computed tomography (CT). Overall, 80 percent had some evidence of SVC compromise. (See "Primary mediastinal large B cell lymphoma", section on 'Oncologic emergencies'.)

- Although most NHLs cause SVC syndrome by extrinsic compression due to enlarged lymph nodes (image 3), patients with intravascular (angiotropic) lymphoma have intravascular

occlusion as the primary pathogenic mechanism [20]. (See "Intravascular large B cell lymphoma".)

Others — Other malignant tumors that are less commonly associated with the SVC syndrome include thymoma and other thymic neoplasms [21,22], primary mediastinal germ cell neoplasms [23], mesothelioma, and solid tumors with mediastinal lymph node metastases (eg, breast cancer) [24].

CLINICAL FEATURES

SVC syndrome is the presenting symptom of a previously undiagnosed tumor in up to 60 percent of these cases. Thus, the history should include evaluation for known risk factors for the types of malignancies known to cause SVC syndrome (eg, smoking, asbestos exposure).

Symptoms and signs — Symptoms and signs of thoracic central venous obstruction can include swelling, chest pain, respiratory symptoms, or neurologic manifestations. Regardless of etiology, face or neck swelling, and dyspnea are common presenting symptoms [4,8,9,25]. (See "Clinical features, diagnosis, and classification of thoracic central venous obstruction".)

Patients frequently complain of facial swelling or head fullness, which may be exacerbated by bending forward or lying down, or arm swelling. Swelling of the head and neck is visually striking but generally of little clinical consequence. However, edema can narrow the lumen of the nasal passages and larynx, potentially compromising the function of the larynx or pharynx and causing dyspnea, stridor, cough, hoarseness, and dysphagia. Respiratory distress can also be related to pleural effusion or pulmonary restriction from severe chest or breast swelling.

In addition, patients with cerebral edema may have headaches, confusion, or visual/auditory disturbances. Cerebral edema can lead to brainstem herniation, and possibly death.

The rapidity of onset of symptoms depends on the time course of SVC invasion or compression, and the severity of luminal compromise. The presence and severity of symptoms and signs of SVC obstruction in turn depends on whether recruitment of venous collaterals has compensated for the narrowing. Acute thrombosis of a prior stable partial obstruction can also occur, leading to abrupt symptoms. (See 'Pathophysiology' above.)

On physical examination, distension of the veins in the neck and on the chest wall may be apparent (picture 1). Arm edema, cyanosis, and facial plethora are less frequent [7,9,24].

Grading symptom severity — A grading system has been proposed that stratifies symptoms based on severity and also informs the approach to diagnosis and treatment (table 1) [26].

Although other grading systems are in use, in general, we prefer this grading system as it informs the diagnostic and therapeutic pathway. (See 'Diagnosis' below and 'Treatment' below and "Clinical features, diagnosis, and classification of thoracic central venous obstruction", section on 'Symptoms and signs'.)

A separate but similar grading system from the National Cancer Institute (the Common Terminology Criteria for Adverse Events [CTCAE]) grades SVC syndrome as an adverse event during cancer therapy (table 2). The grading systems are similar, but asymptomatic patients are regarded as Grade 1 (rather than grade 0), and patients with mild or moderate symptoms are grouped together as Grade 2 (rather than grade 1 or 2).

Chest radiographs — The majority of patients with SVC syndrome have an abnormal chest radiograph. In an early series of 86 patients with SVC syndrome, 84 percent had an abnormal chest radiograph [27]. The most common findings were mediastinal widening and pleural effusion, occurring in 64 and 26 percent of cases, respectively.

Laboratory studies — We routinely obtain a complete blood count and coagulation studies (prothrombin time [PT], activated partial thromboplastin time [aPTT]). Assay of tumor markers may be beneficial for patients with a known diagnosis of malignancy who have had elevations in one or more described tumor markers (eg, human chorionic gonadotropin [HCG], alpha fetoprotein [AFP] for patients with germ cell tumors) that are being used to follow disease course. (See "Serum tumor markers in testicular germ cell tumors".)

Abnormal laboratory results that may support a possible diagnosis of non-Hodgkin lymphoma include unexplained anemia, thrombocytopenia or leukopenia, hypercalcemia, hyperuricemia, and/or elevated levels of serum lactate dehydrogenase. (See "Clinical presentation and initial evaluation of non-Hodgkin lymphoma", section on 'Abnormal laboratory results'.)

DIAGNOSIS

The diagnosis of SVC syndrome may be suspected based on characteristic symptoms and signs of thoracic central venous obstruction. Confirmation of a diagnosis of thoracic central venous obstruction requires imaging, which also frequently confirms malignancy as the etiology. (See 'Symptoms and signs' above and "Clinical features, diagnosis, and classification of thoracic central venous obstruction", section on 'Malignancy'.)

Approach to imaging — The approach to imaging depends on the time course of the presentation and symptom severity [28]. (See 'Clinical features' above and 'Grading symptom

severity' above and "Clinical features, diagnosis, and classification of thoracic central venous obstruction", section on 'Diagnosis'.)

- For patients with severe or life-threatening symptoms (ie, grade 3 or 4; significant cerebral edema [confusion, obtundation], laryngeal edema [stridor], or hemodynamic compromise [syncope without precipitating factors, hypotension, renal insufficiency] (table 1)), contrast enhanced computed tomography (CECT) is the initial diagnostic modality because it is readily available, and provides pertinent information. CECT has a 96 to 98 percent sensitivity and 97 to 99 percent specificity for detecting central venous lesions [29,30]. The presence of collateral vessels on CECT is a strong indicator of SVC syndrome, with a specificity of 96 percent and sensitivity of 92 percent [31-33]. CECT also demonstrates the site(s), level, and extent of venous obstruction, which is critical for planning endovenous intervention. Cross sectional imaging may also demonstrate the etiology of obstruction. Magnetic resonance (MR) venography with appropriate electrocardiogram gating is an alternative to CECT. (See 'Urgency of diagnosis and treatment' below and 'Endovenous recanalization' below.)

- For patients who present with mild symptoms (ie, grade 1; edema of the head or neck, cyanosis, plethora) or moderate symptoms (grade 2; edema in head or neck with mild dysphagia, cough, mild or moderate impairment of the head, jaw or eyelid movements, visual disturbances caused by ocular edema), the initial imaging study may be either a venous duplex study or cross-sectional imaging:

  - Duplex ultrasound is useful for excluding thrombus in the subclavian, axillary, and brachiocephalic veins and is the initial imaging study for patients with mild symptoms who have an indwelling device or a malignancy at low risk to cause SVC syndrome who present with extremity swelling. The SVC cannot be directly imaged using ultrasound due to acoustic shadowing by the overlying ribs. However, indirect findings on duplex ultrasonography that suggest SVC occlusion include dampening of the waveforms of the central upper extremity veins with loss of venous pulsatility and loss of respiratory variation. (See "Catheter-related upper extremity venous thrombosis in adults", section on 'Duplex ultrasonography' and "Clinical features, diagnosis, and classification of thoracic central venous obstruction", section on 'Diagnosis'.)

  - For patients with clinical features suggestive of mild to moderate SVC syndrome, who have a known malignancy that is associated with SVC syndrome, cross-sectional imaging (CECT, magnetic resonance imaging [MRI]) is a more appropriate initial study. As noted above, CECT can define the level and extent of venous blockage, identify and

map collateral pathways of venous drainage, and often permits identification of the underlying cause of venous obstruction.

Imaging techniques

- **Contrast enhanced computed tomography** – CECT of the chest with bilateral upper extremity contrast injection combines the diagnostic benefit of CT with a high degree of enhanced vascular detail (similar to catheter-based venography), provided that the appropriate techniques for intravenous injection of contrast material are used to minimize flow artifacts arising from unopacified blood [34]. Depending on the timing of study, certain vessels may be too much or too little opacified. Complications, including excessive bleeding from venipuncture sites, are uncommon [4,35]. However, contrast-enhanced blood from the collateral circulation draining into the inferior vena cava can simulate the appearance of a liver "hot spot" on CT (image 4).

- **Magnetic resonance venography** – MR venography is an alternative approach that may be useful for patients with an allergy to the iodine-based materials used for contrast-enhanced CT, or for those in whom venous access cannot be obtained for contrast-enhanced studies [28,36-38].

- **Superior vena cavogram** – Conventional catheter-based central venography remains the standard to which other imaging modalities are compared for the diagnosis of SVC obstruction. Conventional venography has the advantage of defining the site, extent of stenosis, associated thrombus, nature of venous obstruction (thrombus, tumor proliferation), the hemodynamic significance of a lesion, and for identifying collateral pathways [28]. However, it does not image the surrounding structures like CECT, and thus will not identify a specific extrinsic cause of SVC obstruction unless thrombosis is the sole etiology. Thus, for most patients, we prefer initial CECT. (See 'Approach to imaging' above.)

Histologic diagnosis — Clinical history combined with CT imaging will generally differentiate between benign causes of SVC obstruction (particularly caval thrombosis) and extrinsic compression related to malignancy. Histologic diagnosis is a prerequisite for choosing appropriate therapy for the patient with SVC syndrome associated with malignancy, particularly since as many as 60 percent of patients present without a prior diagnosis of cancer [7].

Minimally invasive techniques can often be used to establish a tissue diagnosis for patients who present without a prior diagnosis of malignancy:

- Sputum cytology, pleural fluid cytology, and CT-guided biopsy of enlarged peripheral lymph nodes (eg, supraclavicular) may be diagnostic in up to two-thirds of cases [7]. (See

"Evaluation of peripheral lymphadenopathy in adults".)

- Bone marrow biopsies may provide both diagnostic and staging information for patients with suspected non-Hodgkin lymphoma (NHL) or small cell lung cancer (SCLC). (See "Bone marrow aspiration and biopsy: Indications and technique".)

More invasive procedures (bronchoscopy, mediastinoscopy, video-assisted thoracoscopy, thoracotomy) may be indicated when a definitive diagnosis cannot otherwise be established. Such procedures may be particularly useful in establishing the subtype for patients with lymphoma.

Risk of invasive mediastinal procedures — Although some studies report a higher rate of complications from mediastinal procedures among patients who have SVC syndrome [39], most report low rates of complications [4,6,15,35,40-42]. The safety of invasive procedures in most patients with SVC syndrome can be illustrated by the following observations (see "Approach to the adult patient with a mediastinal mass"):

- In one series, 80 consecutive patients underwent cervical mediastinoscopy because of diagnostic uncertainty (n = 51), lack of response to chemotherapy or radiation therapy (n = 17), or as part of their initial management (n = 12) [41]. There was little morbidity and no perioperative mortality; five patients had significant bleeding, but only one required sternotomy. A definitive diagnosis was obtained in all patients.

- A review of 319 patients with SVC syndrome found major hemorrhage in 3 percent of patients undergoing mediastinoscopy or mediastinotomy [35]. Bronchoscopy was associated with a low risk of bleeding and respiratory distress (0.5 percent each).

There are some factors that increase the risk of invasive procedures and anesthesia in patients with SVC syndrome. As examples, the presence of tracheal obstruction can lead to complications from intubation, or the presence of a pericardial effusion can increase the risk of hemodynamic collapse due to cardiac tamponade [7,43]. Such tumor-associated complications can be anticipated based upon the history and physical examination, and the thoracic CT findings. These patients are more safely approached with upfront stenting, followed by an attempt to obtain diagnostic tissue. (See 'Patients without life-threatening symptoms' below.)

Percutaneous transthoracic CT-guided biopsy or endoscopic ultrasound-directed biopsy are alternatives to mediastinoscopy or thoracotomy to establish a definitive diagnosis in high-risk patients [44]. (See "Endoscopic ultrasound-guided sampling of the mediastinum: Technique, indications, contraindications, and complications".)

However, it may not be possible to obtain sufficient material for histology, particularly if a lymphoma is suspected. In such cases, a core needle biopsy is preferable if an excisional lymph node biopsy is not possible.

Differential diagnosis — Nonmalignant conditions account for 15 to 40 percent of SVC obstructions in contemporary retrospective series [4,6,7,27]. Most of these cases are related to the presence of indwelling intravascular devices [4,45]. Other causes include postradiation fibrosis, fibrosing mediastinitis, infection with nocardiosis, and the rare situation of agenesis of the SVC [46]. The absence of adjacent tumor directly invading or causing external compression of the SVC on imaging and having another confirmed diagnosis, or the presence of an indwelling catheter, usually make the distinction. (See "Central vein obstruction associated with upper extremity hemodialysis access" and "Catheter-related upper extremity venous thrombosis in adults".)

Postradiation local vascular fibrosis should always be included in the differential diagnosis of SVC syndrome in patients who have received prior thoracic radiation therapy, even if it predated the condition by several years [47]. (See "Clinical manifestations, prevention, and treatment of radiation-induced fibrosis".)

As many as 50 percent of cases of nonmalignant SVC syndrome are attributable to fibrosing mediastinitis, for which the most common cause is an excessive host response to a prior infection with *Histoplasma capsulatum*. A number of other infections have been associated with fibrosing mediastinitis, including tuberculosis, nocardiosis, actinomycosis, aspergillosis, blastomycosis, and Bancroftian filariasis. These conditions are reviewed separately. (See "Mediastinal granuloma and fibrosing mediastinitis" and "Pathogenesis and clinical features of pulmonary histoplasmosis" and "Nocardia infections: Epidemiology, clinical manifestations, and diagnosis" and "Lymphatic filariasis: Epidemiology, clinical manifestations, and diagnosis" and "Clinical manifestations and diagnosis of blastomycosis".)

A central arteriovenous fistula (eg, following penetrating trauma, ruptured aneurysm) can increase collateral venous flow, mimicking clinical features (swelling, venous patterning), but with an absence of occlusion of the SVC on imaging studies.

TREATMENT

The following sections will emphasize the management of malignant SVC syndrome (tumor invasion, compression by tumor). Management of central vein thrombosis caused by indwelling venous catheters is addressed elsewhere. (See "Catheter-related upper extremity venous

thrombosis in adults" and "Central vein obstruction associated with upper extremity hemodialysis access".)

General principles — The goals of management for malignant SVC syndrome are to alleviate symptoms and treat the underlying disease. Treatment of the underlying cause depends on the type of cancer, the extent of disease, and the overall prognosis, which is closely linked to histology and whether or not prior therapy has been administered [6]. These factors all influence the choice of treatment.

The average life expectancy among patients who present with malignant SVC syndrome is approximately six months, but there is wide variability depending on the underlying malignancy [6,7,48-52]. For some patients, treatment of SVC syndrome and its underlying cause results in long-term relapse-free survival and cure. This is most likely to be achieved in chemotherapy-sensitive malignancies using a combined-modality treatment approach.

Evidence-based guidelines for management of SVC syndrome are not available. A general recommendation supporting radiation therapy (RT) or stent placement for symptomatic SVC syndrome has been made by both the National Comprehensive Cancer Network (NCCN [53]; for patients with advanced malignancy and a life expectancy that is estimated in weeks to months) and the American College of Chest Physicians (ACCP) for lung cancer [54]. Beyond this, specific recommendations for management are lacking.

Initial management should be guided by the severity of symptoms (see 'Grading symptom severity' above) and the underlying malignant condition, as well as the anticipated response to treatment. Our approach to diagnosis and management that is based upon symptom severity and the specific underlying malignancy, and modeled after one proposed by clinicians at Yale University [26], is discussed in more detail in the following sections.

Urgency of diagnosis and treatment — Current management guidelines stress the importance of accurate histologic diagnosis prior to starting tumor-directed therapy [54], and the urgent use of endovenous recanalization with stent placement, as necessary, in severely symptomatic patients to provide more rapid relief than can be achieved using chemotherapy and/or RT. (See 'Patients with life-threatening symptoms' below and 'Histologic diagnosis' above.)

In particular, patients who present with life-threatening symptoms (central airway obstruction, severe laryngeal edema, coma from cerebral edema (table 1)) **represent a true medical emergency, and following initial stabilization (secure airway, support breathing and circulation), these patients require immediate intervention (endovenous recanalization with SVC stent placement, as needed) to decrease the risk of sudden respiratory failure**

and death. This may require emergency transfer to a facility with appropriate endovascular resources. (See 'Patients with life-threatening symptoms' below and "Clinical presentation, diagnostic evaluation, and management of malignant central airway obstruction in adults".)

To control the airway, the patient may require intubation, which can become complicated, requiring anesthesia assistance (algorithm 1 and algorithm 2). (See "Approach to the difficult airway in adults for emergency medicine and critical care" and "Approach to the failed airway in adults for emergency medicine and critical care".)

In the past, it was thought that immediate RT was the quickest way to relieve obstruction in potentially life-threatening malignant SVC syndrome. However, immediate RT is no longer considered the best option for most patients for the following reasons:

- Endovascular recanalization with or without stenting is a faster way to relieve symptoms compared with RT, particularly for patients with life-threatening symptoms. (See 'Patients with life-threatening symptoms' below.)
- RT given prior to biopsy may obscure the histologic diagnosis, if the diagnosis is not certain. As an example, in one study of 19 patients with symptomatic mediastinal masses who received emergency RT, a histologic diagnosis could not be established in eight (42 percent) from a biopsy obtained after such treatment [55].
- If RT is needed, it can be deferred until after severe symptoms have been relieved through endovascular techniques, and a biopsy is secured. Symptomatic obstruction is often a prolonged process, developing over a period of weeks or longer prior to clinical presentation. Deferring therapy until a full diagnostic work-up has been completed does not pose a hazard for most patients, provided the evaluation is efficient and the patient is clinically stable [7].

Supportive care and medical management — When thrombus is present, systemic anticoagulation is generally recommended to limit thrombus extension (in the absence of contraindications) until definitive treatment can be undertaken [56]. (See 'Handling thrombus' below.)

For patients who have obstruction of the SVC resulting from intravascular thrombus associated with an indwelling catheter, removal of the catheter may be indicated in conjunction with systemic anticoagulation. This subject is addressed elsewhere. (See "Catheter-related upper extremity venous thrombosis in adults", section on 'Catheter management'.)

Although there are no data documenting the effectiveness of this maneuver, the head should remain elevated (the higher the better, as tolerated) to decrease hydrostatic pressure and head and neck edema.

Obstruction of blood flow through the SVC slows venous return. This can result in local irritation or thrombosis of veins in the upper extremities, or delayed absorption of drugs from the surrounding tissues. Thus, the use of intramuscular injections in the upper extremities should be avoided. However, intravenous medications can still be given through the patent ipsilateral peripheral arm veins, but we would avoid the use of vesicants in this situation. (See "Extravasation injury from cytotoxic and other noncytotoxic vesicants in adults".)

Glucocorticoids — There are two settings in which systemic administration of glucocorticoids may be helpful:

- For patients receiving RT on an emergency basis for severe airway obstruction that is not amenable to stenting, we suggest a short course of high-dose corticosteroids to minimize the risk of central airway obstruction secondary to edema. Although glucocorticoids are commonly prescribed in this setting, their efficacy has never been formally studied, and there are only case reports to suggest benefit.

- Glucocorticoids can be effective in reversing symptomatic SVC syndrome caused by steroid-responsive malignancies, such as lymphoma or thymoma. However, if a suspected diagnosis of lymphoma has not yet been histologically confirmed, use of glucocorticoids is not advisable, as they are lympholytic and may obscure the diagnosis.

The effectiveness of glucocorticoids in patients with SVC obstruction due to other malignancies, such as non-small cell lung cancer (NSCLC), has never been studied, and they are not indicated in these situations [11].

Diuretics and hydration — In general, overhydration of the patient should be avoided if possible. Diuretics can be used, as needed, but not at the expense of intravascular volume depletion. However, it is unclear whether venous pressures distal to the obstruction are affected by small changes in right atrial pressure [5]. In a retrospective series of 107 patients with SVC syndrome from a variety of causes, the rate of clinical improvement was similar among patients receiving glucocorticoids, diuretics, or both [7].

Patients with life-threatening symptoms — For patients with malignant SVC syndrome who present with life-threatening symptoms (eg, stridor, respiratory compromise, or depressed central nervous system function (table 1)), following initial stabilization (secure airway, support breathing and circulation), we recommend emergency endovenous recanalization (eg,

mechanical thrombolysis, pharmacologic thrombolysis, balloon angioplasty) and SVC stenting, as necessary, rather than immediate RT.

These situations represent a true medical emergency, and these patients require treatment with immediate results to decrease the risk of sudden respiratory failure and death. If the diagnosis demonstrates stenosis without thrombus, endovenous stenting can be life-saving. Following stent placement, in the absence of appreciable thrombus, there is no consensus regarding antithrombotic therapy. (See 'Need for long-term antithrombotic therapy' below and "Endovenous intervention for thoracic central venous obstruction", section on 'Antithrombotic therapy'.)

For patients with a clearly defined thrombus detected by imaging, endovenous thrombolysis is necessary to uncover the location and extent of any venous stenosis, which may be amenable to stenting. Patients with demonstrated thrombus are anticoagulated provided the risk of bleeding is not prohibitive. (See 'Handling thrombus' below and 'Need for long-term antithrombotic therapy' below and "Endovenous intervention for thoracic central venous obstruction", section on 'Antithrombotic therapy'.)

Patients without life-threatening symptoms — Options for patients without life-threatening symptoms depend on the histologic type of the malignancy and the severity of symptoms. Treatment must be individualized. In general:

- The placement of an endovenous stent restores venous return and provides rapid and sustained symptom palliation in patients with malignant SVC syndrome even in the absence of life-threatening symptoms. An endovenous stent is particularly appropriate for rapid symptom palliation in patients with tumors for which response to chemotherapy and/or RT is intermediate or poor (ie, NSCLC and pleural mesothelioma), and for those with recurrent SVC syndrome who have previously received systemic therapy or RT. (See 'Endovenous recanalization' below and "Endovenous intervention for thoracic central venous obstruction", section on 'Stenting as primary therapy'.)

  As noted above, for patients with thrombus, endovenous thrombolysis is necessary to uncover the location and extent of any venous stenosis, which may be amenable to stenting, and the patient is anticoagulated. On the other hand, in the absence of thrombus, there is little consensus on the indications for antithrombotic therapy after stent placement. (See 'Handling thrombus' below and "Endovenous intervention for thoracic central venous obstruction", section on 'Postprocedure care and follow-up'.)

- For patients with chemotherapy-sensitive malignancies such as small cell lung cancer (SCLC) [54], non-Hodgkin lymphoma (NHL), or germ cell cancer (and possibly breast

cancer), initial chemotherapy is the treatment of choice for patients with symptomatic SVC syndrome. The clinical response to chemotherapy alone is usually rapid, and these patients can often achieve long-term remission and durable palliation with standard treatment regimens. (See 'Chemotherapy sensitive malignancy (small cell lung cancer, lymphoma, germ cell tumor)' below.)

- RT is widely advocated for SVC syndrome caused by radiosensitive tumors in patients with other less-chemotherapy-sensitive malignancies who have not been previously irradiated. (See 'Radiation therapy' below.)

- Although surgical resection of mediastinal tumor combined with SVC reconstruction is rarely considered for treatment of SVC syndrome in view of its morbidity and mortality, and the limited life expectancy of most patients who present with this complication, it could be considered in selected cases of thymoma and thymic carcinoma as a component of a multimodality approach to treatment, and for patients with residual masses after treatment of a germ cell tumor. (See 'Patients who might benefit from surgical venous bypass' below.)

Options

Endovenous recanalization — The nature of endovenous intervention depends on whether thrombus is present; often it is not. (See "Overview of thoracic central venous obstruction" and "Endovenous intervention for thoracic central venous obstruction".)

Handling thrombus — When extensive thrombus is present, reducing thrombus burden using thrombolytic techniques alleviates symptoms, and is necessary to uncover venous stenosis and helps to achieve proper stent sizing. It may also reduce the number and length of stents required to recanalize the SVC [51,54,57-59]. Pharmacologic thrombolytic agents (eg, alteplase) increase the risk of bleeding and may be contraindicated (table 3) [60]. In situations where the risk for bleeding is judged to be high, mechanical thrombolysis alone, without thrombolytic agents, can be used.

While pharmacologic thrombolysis after stenting may have once been commonplace [51,61,62], there are only a few scenarios when this might be necessary such as for persistent symptomatic upper extremity thrombus, or for thrombus that remains and will not be covered by a stent, or for thrombus that is protruding through stent struts. In general, even in these situations, once the SVC is recanalized, the lytic agent can be discontinued and full systemic anticoagulation can be initiated. (See 'Need for long-term antithrombotic therapy' below and "Endovenous intervention for thoracic central venous obstruction", section on 'Postprocedure care and follow-up'.)

Stenting

Outcomes — The technical success rate for endovenous stenting in patients with malignant SVC syndrome is in the range of 95 to 100 percent, and over 90 percent of patients report relief of symptoms [50,57,58,61,63-69]. (See "Endovenous intervention for iliocaval venous obstruction".)

Reported recurrence rates of SVC syndrome following stent placement range from 0 to 40 percent (average 13 percent [57]), but in a high proportion of these cases, patency can be restored with reintervention. Long-term outcomes after stent placement have been addressed in the following reports:

- One series included 56 patients who underwent stent placement for SVC syndrome, 40 for malignant, and 16 for benign conditions [70]. A single stent was deployed in 38, while nine (16 percent) required more than one stent to bridge the stenotic area. Patency rates at one year in malignant and benign cases were 64 and 76 percent, respectively.

- A second series included 164 patients with malignant SVC syndrome, with a mean follow-up period of 355 days [71]. Endovenous treatment was successful in 95 percent of cases, with an acceptable rate of early mortality (2.4 percent). Thrombosis of the SVC was the only independent factor for endovenous treatment failure. Relapse occurred in 36 patients (21.9 percent, with effective re-stenting in 75 percent of cases). Recurrence of SVC syndrome was significantly increased in cases of occlusion, initial associated thrombosis, or use of stainless steel stents. Long-term anticoagulation therapy did not influence the risk of recurrence or complications.

- In another series of 56 patients with malignant SVC obstruction, the clinical success rate of SVC stenting was 86 percent [72]. Success was associated with obstruction type, which was classified as follows: group 1 (a, SVC stenosis; or b, unilateral innominate vein occlusion with contralateral innominate vein stenosis and normal SVC), group 2 (SVC occlusion excluding bilateral innominate vein occlusion), and group 3 (bilateral innominate vein occlusion irrespective of SVC status). Success rates were 100 (39 of 39), 75 (9 of 12), and 17 percent (1 of 6), for the three groups, respectively. These differences were significant for group 1 compared with group 2 and 3, and for group 2 compared with group 3. Acute complications occurred in nine patients. Patients in whom acute complications occurred were older than the others (67.8 versus 57.6 years). The procedure-related death rate was 3.5 percent (n = 2). Stent occlusion occurred in 3.5 percent (n = 2). Patient survival was poor (median 2.6 months; range <1 to 29.6 months), independent of the success of stenting. In this report, stenting for malignant SVC syndrome provided immediate and

sustained symptomatic relief, lasting until death in patients with a short life-expectancy, and it restored central venous access for administration of chemotherapy. Technical failure was associated with SVC occlusions and primarily with bilateral innominate vein occlusion.

Both balloon-expandable (stainless steel, cobalt chromium) and self-expanding (stainless steel, nitinol) stents, as well as self-expanding covered stents (polytetrafluoroethylene [PTFE]-coated nitinol) and stent-grafts have been used for treating SVC syndrome. Various publications have found similar results for the different stents [3,50,51,64,71-77]. There appears to be no significant difference in the published outcomes of the three most commonly used stainless steel stents (the Gianturco Z stent, the Palmaz stent, the Wallstent) [57]. Self-expanding stents made from nitinol (a nickel-titanium alloy), a shape memory superelastic alloy, may offer some advantages, including greater flexibility, allowing adaptability to the curves of the vessels, and ease of positioning and deployment [71]. Stent-grafts, which are covered stents (PTFE, Dacron) originally developed for managing arterial aneurysms (partly self-expanding and partly balloon expandable), may improve central venous primary patency [78]. A study that compared stent-grafts with uncovered bare-metal stents showed that the covered stent-grafts provided higher long-term, cumulative patency rates compared with uncovered stents, although there were no differences in clinical success rate or patient survival [74]. These findings warrant further confirmation in large series.

Several dedicated venous stents have been developed and are now available for clinical use in the United States [79,80].

Clinical trials of several available stents (VIRTUS, VIVO, VERNACULAR, ABRE) have demonstrated their safety and efficacy in relieving venous obstructions. Later generation venous stents have generally included an increased stent diameter and length.

Among those without life-threatening symptoms, there are no randomized trials comparing the efficacy of endovenous stents with palliative RT or systemic chemotherapy [81]. The best data on the comparative efficacy of these approaches come from a systematic review of the literature of patients with SVC obstruction due to lung cancer (either SCLC or NSCLC) [11]. Of the 159 patients who underwent stent placement, 95 percent had relief of symptoms, and the incidence of reocclusion (usually due to thrombosis or tumor ingrowth into the stent) was only 11 percent. In contrast, of the over 600 patients with SCLC, chemotherapy alone, chemoradiotherapy, and RT resulted in complete or partial relief of symptoms in 84, 94, and 78 percent of cases, respectively. Among 150 patients with NSCLC, approximately 60 percent had relief with chemotherapy or RT. Overall, relapse rates were lower with SVC stenting (11 versus 17 to 19 percent with RT and/or chemotherapy) in both SCLC and NSCLC. Chemotherapy and RT

are discussed further below. (See 'Radiation therapy' below and 'Chemotherapy sensitive malignancy (small cell lung cancer, lymphoma, germ cell tumor)' below.)

Technique — The stent is placed percutaneously via the internal jugular, basilic/brachial, or femoral veins using moderate sedation and a local anesthetic at the venous access site. A guide wire is manipulated through the stenosis or obstruction, over which one or more stents are deployed across the lesion (image 5). Many interventionalists administer heparin as a bolus of 3000 to 5000 units prior to deploying the stent, although this is not universal [57,82]. It may be necessary to perform an initial angioplasty to predilate the lumen to a diameter that is large enough to accommodate the delivery device and place the stent [61]. A single stent may not be sufficient to bridge the entire extent of the stenotic area, particularly if both of the brachiocephalic veins are also obstructed, in which case "kissing stents" in addition to a separate SVC stent will be needed [70]. The brachiocephalic stents are positioned with each overriding the confluence in parallel so that each extends into the SVC "kissing" each other.

Thrombotic occlusion of the SVC is not a contraindication to endovenous stent placement, nor is the presence of thrombus within the area of stenosis [83,84]. It may be necessary to clear the thrombus before proceeding [61]. (See 'Handling thrombus' above.)

Stent complications — Complications of SVC stent placement are reported in 3 to 7 percent of patients [5]. Early complications include access site infection, bleeding or hematoma formation, pulmonary embolism, perforation or rupture of the SVC (which is rare), and stent migration [50,85,86]. Late complications include bleeding (1 to 14 percent) and death (1 to 2 percent) from anticoagulation, and loss of stent patency. There is some evidence that the use of stents over 16 mm in diameter may be associated with higher complication rates [71].

Loss of stent patency is most often caused by thrombus or tumor ingrowth. However, since most patients with malignancy-related SVC syndrome have a short life expectancy, the stent usually remains patent until death [3]. If reocclusion does occur, it can be treated with re-intervention (eg, endovenous thrombus removal, stent) with good secondary patency rates [3,11,82]. (See 'Handling thrombus' above.)

Need for long-term antithrombotic therapy — Short-term anticoagulation/antiplatelet therapy is recommended for the treatment of central vein thrombosis. Following SVC stent placement for obstruction, in the absence of significant thrombosis, whether long-term antithrombotic therapy is necessary is an area of uncertainty [5,48-50,57,61,64-66,69,71]. There are no reliable studies and little consensus on the indications for antithrombotic therapy in this situation [49,57,66]. To prevent stent reocclusion in the face of malignancy, some advocate anticoagulation for periods of one to nine months [50,59,64,75,87], while others suggest

antiplatelet therapy alone [82,88]. We typically suggest two to three months of therapy with clopidogrel plus aspirin (if there is no direct contraindication to the use of aspirin). For patients thought to have a hypercoagulable state related to their malignancy, we may use a low molecular weight heparin (eg, enoxaparin) or a direct oral anticoagulant (DOAC) such as apixaban rather than clopidogrel. (See "Cancer-associated hypercoagulable state: Causes and mechanisms" and "Anticoagulation therapy for venous thromboembolism (lower extremity venous thrombosis and pulmonary embolism) in adult patients with malignancy".)

We also tailor the approach to the specific tumor being treated. As an example, if the tumor is progressing or the patient has a tumor such as advanced pancreatic or gastric cancer that is frequently associated with a hypercoagulable state, we would not be inclined to discontinue anticoagulation unless a contraindication to anticoagulation arose. (See "Overview of iliocaval venous obstruction" and "Cancer-associated hypercoagulable state: Causes and mechanisms".)

Radiation therapy — RT has been widely advocated for SVC syndrome caused by radiosensitive tumors in patients who have not been previously irradiated. When effective, RT provides considerable relief by reducing tumor burden [89].

Most of the malignancies causing SVC syndrome are radiation sensitive, and at least in lung cancer, symptomatic improvement is usually apparent within 72 hours. In a systematic review, RT was associated with complete relief of symptoms of SVC obstruction within two weeks in 78 and 63 percent of patients with SCLC and NSCLC, respectively [11]. The rates of relapse posttreatment were 17 and 19 percent for SCLC and NSCLC, respectively.

Despite these data, for most patients, stent placement is preferred over urgent RT for the following reasons:

- Objective measurement of the change in vena caval obstruction may not parallel measures of symptomatic improvement [5]. In an autopsy series [35], complete and partial SVC patency was found in only 14 and 10 percent of patients after RT for SVC syndrome, despite reported relief of symptoms in 85 percent [35]. These data have led some to suggest that the development of collateralization may have contributed more to symptomatic improvement than the effect of RT, and to question the value of urgent RT in patients with SVC syndrome from chemotherapy-sensitive malignancies [5].

- With RT, relief of symptoms may not be achieved for up to four weeks, and approximately 20 percent of patients do not obtain symptomatic relief from RT [9,11,24,51,90].

- Furthermore, the benefits of RT are often temporary, with many patients developing recurrent symptoms before dying of the underlying disease [51,91].

If symptoms are severe, more rapid palliation can be achieved through the use of an endovenous stent, followed by RT for disease control. Stent placement is also effective in relieving symptoms in patients who fail to respond to RT [26]. (See 'Stenting' above and "Endovenous intervention for thoracic central venous obstruction", section on 'Stenting for failed angioplasty'.)

Chemotherapy sensitive malignancy (small cell lung cancer, lymphoma, germ cell tumor) — For patients with SCLC [54], NHL, or germ cell cancer (and possibly breast cancer), initial chemotherapy is the treatment of choice for patients with non-life-threatening symptomatic SVC syndrome, especially if treatment-naive. In these settings, the clinical response to chemotherapy alone is usually rapid. Furthermore, these patients can often achieve long-term remission and durable palliation with standard treatment regimens [12-17]. When chemotherapy is the initial intervention of choice and the SVC obstruction is unrelieved, chemotherapy should be administered through a dorsal foot vein [14] or, in the case of antineoplastic vesicants (eg, anthracyclines), via femoral central venous access (eg, Port-A-Cath). (See "Extravasation injury from cytotoxic and other noncytotoxic vesicants in adults".)

Symptomatic improvement usually occurs within one to two weeks of treatment initiation. In a review of treatment for SVC obstruction in patients with lung cancer, chemotherapy alone relieved symptoms of SVC obstruction in 77 percent of those with SCLC, although 17 percent had a later recurrence [11]. (See "Extensive-stage small cell lung cancer: Initial management" and "Extragonadal germ cell tumors involving the mediastinum and retroperitoneum".)

For these malignancies, use of RT alone usually yields poorer long-term results and may compromise the subsequent results of chemotherapy [14,17]. However, in certain situations (eg, limited-stage SCLC, some subtypes of NHL), the addition of RT to systemic chemotherapy may decrease local recurrence rates and improve overall survival. (See "Limited-stage small cell lung cancer: Initial management".)

With these treatment-responsive tumors, presentation with SVC syndrome does not necessarily portend an adverse outcome compared with patients without SVC obstruction. As an example, among patients with SCLC, some series noted paradoxically better survival among those presenting with SVC syndrome [13,16,92], while others found no impact [12,14,15].

On the other hand, for heavily pretreated patients who develop SVC syndrome after having been exposed to most of the active agents for their particular malignancy, alternative forms of therapy (eg, RT, endovenous stent placement) may be needed for symptom control.

Non-small cell lung cancer — As compared with more chemotherapy-sensitive SCLC, the degree and rapidity of response to chemotherapy are less in NSCLC. Symptom relief in this

setting may be more rapidly achieved by the use of an endovenous stent followed by antitumor therapy, even in the absence of life-threatening symptoms. (See 'Patients without life-threatening symptoms' above and "Overview of the initial treatment of advanced non-small cell lung cancer".)

SVC obstruction is a strong predictor of poor prognosis in patients with NSCLC, with a median survival of only five months in one series [83]. Although long-term relapse-free survival has been rarely reported in patients with locally advanced disease and SVC syndrome treated with chemotherapy alone [84], or a combined modality approach that includes both RT and chemotherapy [93], therapy of SVC syndrome in patients with NSCLC is most often directed toward palliation of symptoms rather than long-term remission. For previously unirradiated patients, palliation is most often achieved with external beam irradiation.

Patients who might benefit from surgical venous bypass

Thymoma and thymic carcinoma — Malignant thymoma and thymic carcinoma are relatively resistant to both chemotherapy and radiation. Although surgical resection of mediastinal tumor combined with reconstruction of the SVC is rarely considered for treatment of SVC syndrome in view of its morbidity and mortality [94-96], and the limited life expectancy of most patients who present with this complication, it could be considered in selected cases as a component of a multimodality approach to treatment [97,98]. (See "Clinical presentation and management of thymoma and thymic carcinoma".)

Residual mass after treatment for germ cell tumor — Another setting in which surgical venous bypass could be considered is in patients with residual disease after treatment for a germ cell tumor. (See "Approach to surgery following chemotherapy for advanced testicular germ cell tumors", section on 'Mediastinal disease'.)

Technique — Surgical bypass can be performed using a variety of techniques (eg, vein, PTFE graft) [99-101]; however, there is no consensus as to the optimal technique, configuration, or conduit. (See "Techniques used for open iliocaval venous reconstruction".)

SUMMARY AND RECOMMENDATIONS

- **Etiology and clinical presentation**
  - Superior vena cava (SVC) syndrome results from obstruction of blood flow in the SVC. The majority of cases are due to lung cancer or non-Hodgkin lymphoma (NHL). Patients with malignancy have a higher risk of venous thrombosis related to indwelling venous

devices (eg, central venous catheter, pacemaker). (See 'Pathophysiology' above and 'Typical malignancies' above.)

- Symptoms and signs of thoracic central venous obstruction can include facial or upper extremity edema, chest pain, respiratory symptoms, or neurologic manifestations. Dyspnea is the most common presenting symptom. (See 'Symptoms and signs' above.)

- We use a grading system that stratifies symptoms based on severity and also informs the approach to diagnosis and treatment (table 1) [26]. (See 'Grading symptom severity' above.)

- The approach to imaging depends on the time course of the presentation and symptom severity (see 'Approach to imaging' above):

  - For most patients with symptoms suggestive of malignancy related SVC syndrome, contrast-enhanced CT provides the most expedient diagnosis.

  - Duplex ultrasound may be useful for excluding thrombus in the subclavian and axillary, and is an appropriate initial imaging study for patients with mild symptoms who have an indwelling device or a malignancy at low risk for causing SVC syndrome.

- **Need for tissue diagnosis** – Approximately 60 percent of patients present with SVC syndrome without a preexisting diagnosis of cancer. If the imaging studies are consistent with a malignancy, a histologic diagnosis is required prior to initiating specific antitumor therapy. (See 'Histologic diagnosis' above.)

- **Initial approach to treatment**

  - The goals of management are to alleviate symptoms and treat the underlying disease.

  - Emergency radiation therapy (RT) is no longer considered necessary for most patients. Current guidelines stress the importance of accurate histologic diagnosis prior to starting therapy and the upfront use of endovenous therapy (eg, stenting) in severely symptomatic patients to provide more rapid symptom relief than can be achieved using RT. (See 'Histologic diagnosis' above.)

  - Patients who present with stridor due to central airway obstruction or severe laryngeal edema, or coma from cerebral edema, **represent a true medical emergency, and following initial stabilization (secure airway, support breathing and circulation), and expedient confirmation of the diagnosis, these patients require immediate**

endovenous intervention (ie, thrombus removal/stent placement) to decrease the risk of sudden respiratory failure and death. This may require emergency transfer to a facility with appropriate endovascular resources.

- **Definitive treatment**

  - For patients **with life-threatening symptoms** (ie, stridor, respiratory compromise, or depressed central nervous system function), we recommend emergency treatment with endovenous intervention rather than initial RT (**Grade 1B**). (See 'Patients with life-threatening symptoms' above and 'Urgency of diagnosis and treatment' above.)

  - The need for and method of thrombus removal should be individualized. If extensive thrombus is present, reducing thrombus burden may be necessary to demonstrate the venous stenosis and may simplify the stenting procedure. Pharmacologic thrombolysis (eg, alteplase) increases the risk of bleeding and may be contraindicated. (See 'Handling thrombus' above.)

    Patients with demonstrated thrombus require anticoagulation, provided the risk of bleeding is not prohibitive. There is little consensus on the indications for antithrombotic therapy after SVC stent placement for stenosis in the absence of thrombus. For most patients, we suggest a two- to three-month course of antiplatelet therapy (**Grade 2C**). Either clopidogrel alone or clopidogrel plus aspirin can be used. For patients thought to have a hypercoagulable state related to their malignancy, we suggest a low molecular weight heparin (eg, enoxaparin) or a direct oral anticoagulant (DOAC) such as apixaban rather than clopidogrel (**Grade 2C**). (See 'Need for long-term antithrombotic therapy' above.)

  - Options for patients **with no life-threatening symptoms** depend on the histologic type of the malignancy and the severity of symptoms. Treatment must be individualized. In general (see 'Patients without life-threatening symptoms' above):

    - The placement of an endovenous stent restores venous return and provides rapid and sustained symptom palliation in patients with malignant SVC syndrome even in the absence of life-threatening symptoms. An endovenous stent is particularly appropriate for rapid symptom palliation in patients with tumors for which response to chemotherapy and/or RT is intermediate or poor (ie, non-small cell lung cancer [NSCLC] and pleural mesothelioma), and for those with recurrent SVC syndrome who have previously received systemic therapy or RT. (See 'Stenting' above.)

- For patients with highly chemotherapy-sensitive malignancies, such as small cell lung cancer (SCLC), NHL, or germ cell cancer (and possibly breast cancer), we suggest systemic chemotherapy rather than RT or an endovenous stent (**Grade 2C**). (See 'Chemotherapy sensitive malignancy (small cell lung cancer, lymphoma, germ cell tumor)' above.)

- For patients with newly diagnosed NSCLC, we suggest placement of an endovenous stent rather than initial chemotherapy for relief of symptoms (**Grade 2C**). Following stent placement, we suggest RT, either alone or as part of a combined modality approach, to treat the mediastinal disease (**Grade 2C**). (See 'Non-small cell lung cancer' above and 'Radiation therapy' above.)

- Surgical resection of mediastinal tumor combined with SVC reconstruction could be considered in highly selected cases of thymoma and thymic carcinoma as a component of a multimodality approach to treatment, and for patients with residual masses after treatment of a germ cell tumor. (See 'Patients who might benefit from surgical venous bypass' above.)

REFERENCES

1. Friedman T, Quencer KB, Kishore SA, et al. Malignant Venous Obstruction: Superior Vena Cava Syndrome and Beyond. Semin Intervent Radiol 2017; 34:398.
2. Kalra M, Sen I, Gloviczki P. Endovenous and Operative Treatment of Superior Vena Cava Syndrome. Surg Clin North Am 2018; 98:321.
3. García Mónaco R, Bertoni H, Pallota G, et al. Use of self-expanding vascular endoprostheses in superior vena cava syndrome. Eur J Cardiothorac Surg 2003; 24:208.
4. Rice TW, Rodriguez RM, Light RW. The superior vena cava syndrome: clinical characteristics and evolving etiology. Medicine (Baltimore) 2006; 85:37.
5. Wilson LD, Detterbeck FC, Yahalom J. Clinical practice. Superior vena cava syndrome with malignant causes. N Engl J Med 2007; 356:1862.
6. Yellin A, Rosen A, Reichert N, Lieberman Y. Superior vena cava syndrome. The myth--the facts. Am Rev Respir Dis 1990; 141:1114.
7. Schraufnagel DE, Hill R, Leech JA, Pare JA. Superior vena caval obstruction. Is it a medical emergency? Am J Med 1981; 70:1169.

8. Markman M. Diagnosis and management of superior vena cava syndrome. Cleve Clin J Med 1999; 66:59.
9. Armstrong BA, Perez CA, Simpson JR, Hederman MA. Role of irradiation in the management of superior vena cava syndrome. Int J Radiat Oncol Biol Phys 1987; 13:531.
10. Salsali M, Cliffton EE. Superior vena caval obstruction in carcinoma of lung. N Y State J Med 1969; 69:2875.
11. Rowell NP, Gleeson FV. Steroids, radiotherapy, chemotherapy and stents for superior vena caval obstruction in carcinoma of the bronchus: a systematic review. Clin Oncol (R Coll Radiol) 2002; 14:338.
12. Dombernowsky P, Hansen HH. Combination chemotherapy in the management of superior vena caval obstruction in small-cell anaplastic carcinoma of the lung. Acta Med Scand 1978; 204:513.
13. Spiro SG, Shah S, Harper PG, et al. Treatment of obstruction of the superior vena cava by combination chemotherapy with and without irradiation in small-cell carcinoma of the bronchus. Thorax 1983; 38:501.
14. Sculier JP, Evans WK, Feld R, et al. Superior vena caval obstruction syndrome in small cell lung cancer. Cancer 1986; 57:847.
15. Urban T, Lebeau B, Chastang C, et al. Superior vena cava syndrome in small-cell lung cancer. Arch Intern Med 1993; 153:384.
16. Würschmidt F, Bünemann H, Heilmann HP. Small cell lung cancer with and without superior vena cava syndrome: a multivariate analysis of prognostic factors in 408 cases. Int J Radiat Oncol Biol Phys 1995; 33:77.
17. Perez-Soler R, McLaughlin P, Velasquez WS, et al. Clinical features and results of management of superior vena cava syndrome secondary to lymphoma. J Clin Oncol 1984; 2:260.
18. Presswala RG, Hiranandani NL. Pleural effusion and superior vena cava canal syndrome in Hodgkin's disease. J Indian Med Assoc 1965; 45:502.
19. Lazzarino M, Orlandi E, Paulli M, et al. Primary mediastinal B-cell lymphoma with sclerosis: an aggressive tumor with distinctive clinical and pathologic features. J Clin Oncol 1993; 11:2306.
20. Savarese DM, Zavarin M, Smyczynski MS, et al. Superior vena cava syndrome secondary to an angiotropic large cell lymphoma. Cancer 2000; 89:2515.
21. Airan B, Sharma R, Iyer KS, et al. Malignant thymoma presenting as intracardiac tumor and superior vena caval obstruction. Ann Thorac Surg 1990; 50:989.

22. Dib HR, Friedman B, Khouli HI, et al. Malignant thymoma. A complicated triad of SVC syndrome, cardiac tamponade, and DIC. Chest 1994; 105:941.
23. Holbert BL, Libshitz HI. Superior vena caval syndrome in primary mediastinal germ cell tumors. Can Assoc Radiol J 1986; 37:182.
24. Chen JC, Bongard F, Klein SR. A contemporary perspective on superior vena cava syndrome. Am J Surg 1990; 160:207.
25. Bell DR, Woods RL, Levi JA. Superior vena caval obstruction: a 10-year experience. Med J Aust 1986; 145:566.
26. Yu JB, Wilson LD, Detterbeck FC. Superior vena cava syndrome--a proposed classification system and algorithm for management. J Thorac Oncol 2008; 3:811.
27. Parish JM, Marschke RF Jr, Dines DE, Lee RE. Etiologic considerations in superior vena cava syndrome. Mayo Clin Proc 1981; 56:407.
28. Sonavane SK, Milner DM, Singh SP, et al. Comprehensive Imaging Review of the Superior Vena Cava. Radiographics 2015; 35:1873.
29. Cansu A, Soyturk M, Ozturk MH, et al. Diagnostic value of color Doppler ultrasonography and MDCT angiography in complications of hemodialysis fistulas and grafts. Eur J Radiol 2013; 82:1436.
30. Ko SF, Huang CC, Ng SH, et al. MDCT angiography for evaluation of the complete vascular tree of hemodialysis fistulas. AJR Am J Roentgenol 2005; 185:1268.
31. Bechtold RE, Wolfman NT, Karstaedt N, Choplin RH. Superior vena caval obstruction: detection using CT. Radiology 1985; 157:485.
32. Kim HJ, Kim HS, Chung SH. CT diagnosis of superior vena cava syndrome: importance of collateral vessels. AJR Am J Roentgenol 1993; 161:539.
33. Eren S, Karaman A, Okur A. The superior vena cava syndrome caused by malignant disease. Imaging with multi-detector row CT. Eur J Radiol 2006; 59:93.
34. Qanadli SD, El Hajjam M, Bruckert F, et al. Helical CT phlebography of the superior vena cava: diagnosis and evaluation of venous obstruction. AJR Am J Roentgenol 1999; 172:1327.
35. Ahmann FR. A reassessment of the clinical implications of the superior vena caval syndrome. J Clin Oncol 1984; 2:961.
36. Lin J, Zhou KR, Chen ZW, et al. Vena cava 3D contrast-enhanced MR venography: a pictorial review. Cardiovasc Intervent Radiol 2005; 28:795.
37. Thornton MJ, Ryan R, Varghese JC, et al. A three-dimensional gadolinium-enhanced MR venography technique for imaging central veins. AJR Am J Roentgenol 1999; 173:999.

38. Cline B, Hurwitz LM, Kim CY. MR Venography of the Central Veins of the Thorax. Top Magn Reson Imaging 2017; 26:167.
39. Dosios T, Theakos N, Chatziantoniou C. Cervical mediastinoscopy and anterior mediastinotomy in superior vena cava obstruction. Chest 2005; 128:1551.
40. Ferrari LR, Bedford RF. General anesthesia prior to treatment of anterior mediastinal masses in pediatric cancer patients. Anesthesiology 1990; 72:991.
41. Mineo TC, Ambrogi V, Nofroni I, Pistolese C. Mediastinoscopy in superior vena cava obstruction: analysis of 80 consecutive patients. Ann Thorac Surg 1999; 68:223.
42. Porte H, Metois D, Finzi L, et al. Superior vena cava syndrome of malignant origin. Which surgical procedure for which diagnosis? Eur J Cardiothorac Surg 2000; 17:384.
43. Pullerits J, Holzman R. Anaesthesia for patients with mediastinal masses. Can J Anaesth 1989; 36:681.
44. Cosmo L, Haponik EF, Darlak JJ, Summer WR. Neoplastic superior vena caval obstruction: diagnosis with percutaneous needle aspiration. Am J Med Sci 1987; 293:99.
45. Rozmus G, Daubert JP, Huang DT, et al. Venous thrombosis and stenosis after implantation of pacemakers and defibrillators. J Interv Card Electrophysiol 2005; 13:9.
46. De Souza VR Jr, Lemos VMV, Lafayette DSA, et al. The first reported case of factor V Leiden mutation with agenesis of superior vena cava: A case report. Medicine (Baltimore) 2018; 97:e10511.
47. Van Putten JW, Schlosser NJ, Vujaskovic Z, et al. Superior vena cava obstruction caused by radiation induced venous fibrosis. Thorax 2000; 55:245.
48. Greillier L, Barlési F, Doddoli C, et al. Vascular stenting for palliation of superior vena cava obstruction in non-small-cell lung cancer patients: a future 'standard' procedure? Respiration 2004; 71:178.
49. Marcy PY, Magné N, Bentolila F, et al. Superior vena cava obstruction: is stenting necessary? Support Care Cancer 2001; 9:103.
50. Nagata T, Makutani S, Uchida H, et al. Follow-up results of 71 patients undergoing metallic stent placement for the treatment of a malignant obstruction of the superior vena cava. Cardiovasc Intervent Radiol 2007; 30:959.
51. Kee ST, Kinoshita L, Razavi MK, et al. Superior vena cava syndrome: treatment with catheter-directed thrombolysis and endovascular stent placement. Radiology 1998; 206:187.
52. Morin S, Grateau A, Reuter D, et al. Management of superior vena cava syndrome in critically ill cancer patients. Support Care Cancer 2018; 26:521.

53. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology. Available at: https://www.nccn.org/professionals/physician_gls/pdf/gist.pdf (Accessed on July 25, 2023).
54. Kvale PA, Selecky PA, Prakash UB, American College of Chest Physicians. Palliative care in lung cancer: ACCP evidence-based clinical practice guidelines (2nd edition). Chest 2007; 132:368S.
55. Loeffler JS, Leopold KA, Recht A, et al. Emergency prebiopsy radiation for mediastinal masses: impact on subsequent pathologic diagnosis and outcome. J Clin Oncol 1986; 4:716.
56. Stevens SM, Woller SC, Kreuziger LB, et al. Antithrombotic Therapy for VTE Disease: Second Update of the CHEST Guideline and Expert Panel Report. Chest 2021; 160:e545.
57. Uberoi R. Quality assurance guidelines for superior vena cava stenting in malignant disease. Cardiovasc Intervent Radiol 2006; 29:319.
58. Crowe MT, Davies CH, Gaines PA. Percutaneous management of superior vena cava occlusions. Cardiovasc Intervent Radiol 1995; 18:367.
59. Stock KW, Jacob AL, Proske M, et al. Treatment of malignant obstruction of the superior vena cava with the self-expanding Wallstent. Thorax 1995; 50:1151.
60. Warner P, Uberoi R. Superior vena cava stenting in the 21st century. Postgrad Med J 2013; 89:224.
61. Schindler N, Vogelzang RL. Superior vena cava syndrome. Experience with endovascular stents and surgical therapy. Surg Clin North Am 1999; 79:683.
62. Chatziioannou A, Alexopoulos T, Mourikis D, et al. Stent therapy for malignant superior vena cava syndrome: should be first line therapy or simple adjunct to radiotherapy. Eur J Radiol 2003; 47:247.
63. Tanigawa N, Sawada S, Mishima K, et al. Clinical outcome of stenting in superior vena cava syndrome associated with malignant tumors. Comparison with conventional treatment. Acta Radiol 1998; 39:669.
64. Urruticoechea A, Mesía R, Domínguez J, et al. Treatment of malignant superior vena cava syndrome by endovascular stent insertion. Experience on 52 patients with lung cancer. Lung Cancer 2004; 43:209.
65. Oudkerk M, Kuijpers TJ, Schmitz PI, et al. Self-expanding metal stents for palliative treatment of superior vena caval syndrome. Cardiovasc Intervent Radiol 1996; 19:146.
66. Nicholson AA, Ettles DF, Arnold A, et al. Treatment of malignant superior vena cava obstruction: metal stents or radiation therapy. J Vasc Interv Radiol 1997; 8:781.

67. Baltayiannis N, Magoulas D, Anagnostopoulos D, et al. Percutaneous stent placement in malignant cases of superior vena cava syndrome. J BUON 2005; 10:377.
68. Courtheoux P, Alkofer B, Al Refaï M, et al. Stent placement in superior vena cava syndrome. Ann Thorac Surg 2003; 75:158.
69. Smayra T, Otal P, Chabbert V, et al. Long-term results of endovascular stent placement in the superior caval venous system. Cardiovasc Intervent Radiol 2001; 24:388.
70. Barshes NR, Annambhotla S, El Sayed HF, et al. Percutaneous stenting of superior vena cava syndrome: treatment outcome in patients with benign and malignant etiology. Vascular 2007; 15:314.
71. Fagedet D, Thony F, Timsit JF, et al. Endovascular treatment of malignant superior vena cava syndrome: results and predictive factors of clinical efficacy. Cardiovasc Intervent Radiol 2013; 36:140.
72. Sobrinho G, Aguiar P. Stent placement for the treatment of malignant superior vena cava syndrome - a single-center series of 56 patients. Arch Bronconeumol 2014; 50:135.
73. Białkowski J, Szkutnik M, Fiszer R, et al. Percutaneous dilatation of coarctation of the aorta, stenotic pulmonary arteries or homografts, and stenotic superior vena cava using Andrastents XL and XXL. Kardiol Pol 2011; 69:1213.
74. Gwon DI, Ko GY, Kim JH, et al. Malignant superior vena cava syndrome: a comparative cohort study of treatment with covered stents versus uncovered stents. Radiology 2013; 266:979.
75. Dinkel HP, Mettke B, Schmid F, et al. Endovascular treatment of malignant superior vena cava syndrome: is bilateral wallstent placement superior to unilateral placement? J Endovasc Ther 2003; 10:788.
76. Nguyen NP, Borok TL, Welsh J, Vinh-Hung V. Safety and effectiveness of vascular endoprosthesis for malignant superior vena cava syndrome. Thorax 2009; 64:174.
77. Lanciego C, Pangua C, Chacón JI, et al. Endovascular stenting as the first step in the overall management of malignant superior vena cava syndrome. AJR Am J Roentgenol 2009; 193:549.
78. Quaretti P, Galli F, Moramarco LP, et al. Stent Grafts Provided Superior Primary Patency for Central Venous Stenosis Treatment in Comparison with Angioplasty and Bare Metal Stent: A Retrospective Single Center Study on 70 Hemodialysis Patients. Vasc Endovascular Surg 2016; 50:221.
79. Murphy E. Surveying the 2019 Venous Stent Landscape. Endovascular Today 2019; 18:53.

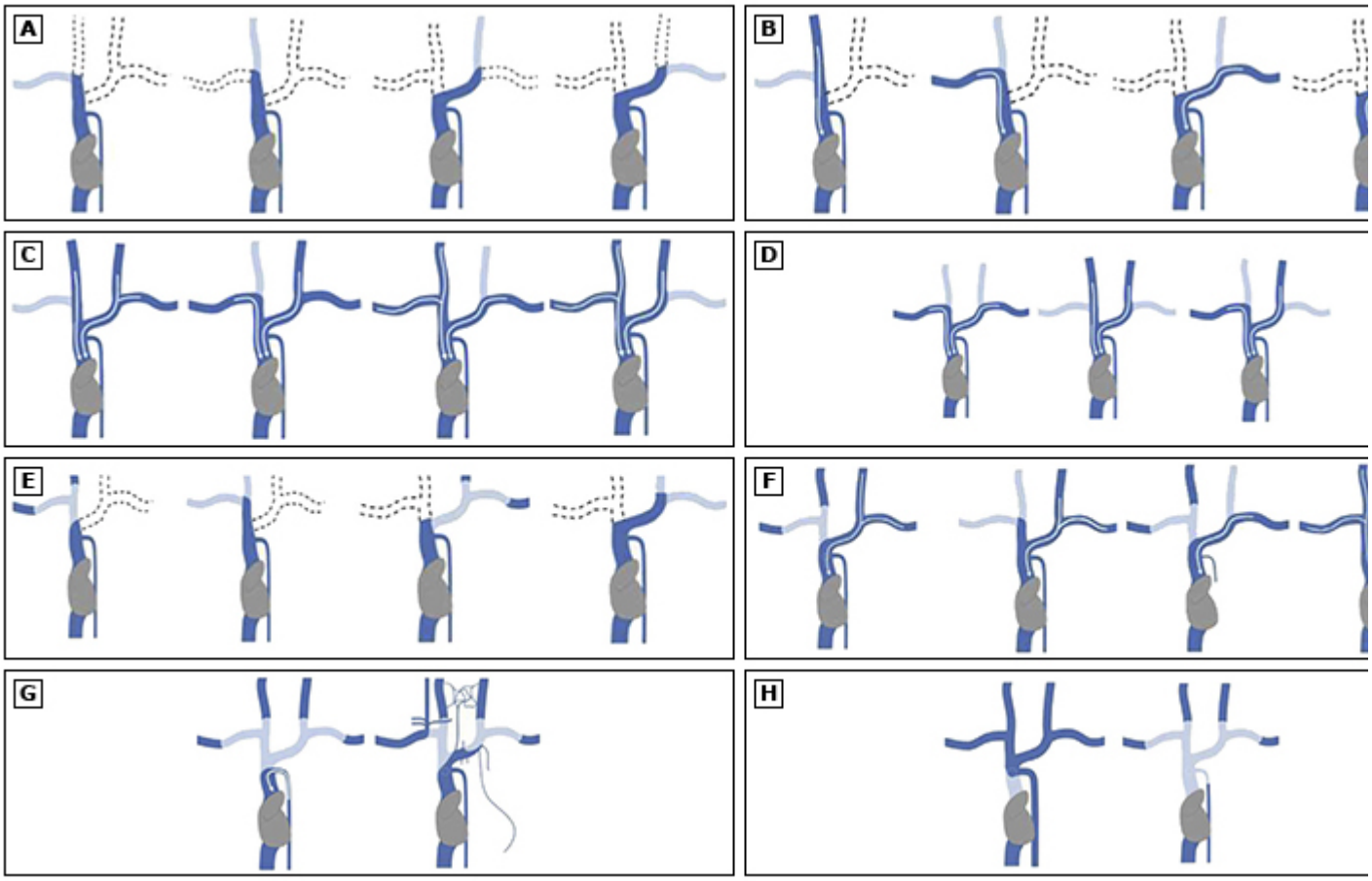
80. Shamimi-Noori SM, Clark TWI. Venous Stents: Current Status and Future Directions. Tech Vasc Interv Radiol 2018; 21:113.
81. Wilson P, Bezjak A, Asch M, et al. The difficulties of a randomized study in superior vena caval obstruction. J Thorac Oncol 2007; 2:514.
82. Lanciego C, Chacón JL, Julián A, et al. Stenting as first option for endovascular treatment of malignant superior vena cava syndrome. AJR Am J Roentgenol 2001; 177:585.
83. Martins SJ, Pereira JR. Clinical factors and prognosis in non-small cell lung cancer. Am J Clin Oncol 1999; 22:453.
84. Citron ML, Fossieck BE Jr, Krasnow SH, et al. Superior vena cava syndrome due to non--small-cell lung cancer. Resolution with chemotherapy alone. JAMA 1983; 250:71.
85. Martin M, Baumgartner I, Kolb M, et al. Fatal pericardial tamponade after Wallstent implantation for malignant superior vena cava syndrome. J Endovasc Ther 2002; 9:680.
86. Smith SL, Manhire AR, Clark DM. Delayed spontaneous superior vena cava perforation associated with a SVC wallstent. Cardiovasc Intervent Radiol 2001; 24:286.
87. Hennequin LM, Fade O, Fays JG, et al. Superior vena cava stent placement: results with the Wallstent endoprosthesis. Radiology 1995; 196:353.
88. Gross CM, Krämer J, Waigand J, et al. Stent implantation in patients with superior vena cava syndrome. AJR Am J Roentgenol 1997; 169:429.
89. Levitt SH, Jones TK Jr, Kilpatrick SJ Jr, Bogardus CR Jr. Treatment of malignant superior vena caval obstruction. A randomized study. Cancer 1969; 24:447.
90. Mose S, Stabik C, Eberlein K, et al. Retrospective analysis of the superior vena cava syndrome in irradiated cancer patients. Anticancer Res 2006; 26:4933.
91. Baker GL, Barnes HJ. Superior vena cava syndrome: etiology, diagnosis, and treatment. Am J Crit Care 1992; 1:54.
92. Warde P, Payne D. Does thoracic irradiation improve survival and local control in limited-stage small-cell carcinoma of the lung? A meta-analysis. J Clin Oncol 1992; 10:890.
93. Roberts JR, Bueno R, Sugarbaker DJ. Multimodality treatment of malignant superior vena caval syndrome. Chest 1999; 116:835.
94. Bacha EA, Chapelier AR, Macchiarini P, et al. Surgery for invasive primary mediastinal tumors. Ann Thorac Surg 1998; 66:234.
95. Chen KN, Xu SF, Gu ZD, et al. Surgical treatment of complex malignant anterior mediastinal tumors invading the superior vena cava. World J Surg 2006; 30:162.

96. Inoue M, Minami M, Shiono H, et al. Efficient clinical application of percutaneous cardiopulmonary support for perioperative management of a huge anterior mediastinal tumor. J Thorac Cardiovasc Surg 2006; 131:755.
97. Shimizu N, Moriyama S, Aoe M, et al. The surgical treatment of invasive thymoma. Resection with vascular reconstruction. J Thorac Cardiovasc Surg 1992; 103:414.
98. Charokopos N, Antonitsis P, Klimatsidas M, et al. Secondary endovascular repair of a reconstructed superior vena cava in a patient with a malignant thymic epithelial neoplasm. Thorac Cardiovasc Surg 2007; 55:267.
99. Okereke IC, Kesler KA, Rieger KM, et al. Results of superior vena cava reconstruction with externally stented-polytetrafluoroethylene vascular prostheses. Ann Thorac Surg 2010; 90:383.
100. Magnan PE, Thomas P, Giudicelli R, et al. Surgical reconstruction of the superior vena cava. Cardiovasc Surg 1994; 2:598.
101. Nakano T, Endo S, Kanai Y, et al. Surgical outcomes after superior vena cava reconstruction with expanded polytetrafluoroethylene grafts. Ann Thorac Cardiovasc Surg 2014; 20:310.

Topic 2832 Version 31.0

GRAPHICS

Types of thoracic central venous obstruction



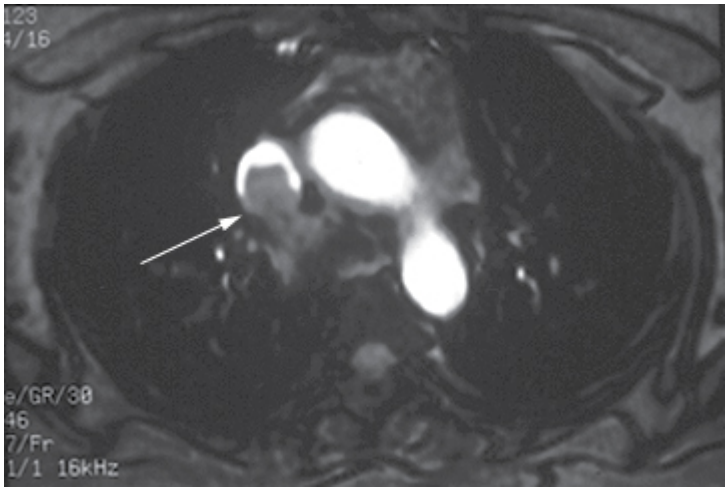
Four patterns of TCVO:

- **Type 1: (A-D)** Both BCVs and the SVC are patent, but one IJV or SCV is obstructed. If patency of all thoracic veins cannot be determined, this type of TCVO can be classified as type 1A or type 1B.
  - **Type 1A: (A)** Unilateral IJV or SCV obstruction with patent ipsilateral BCV; patency of all other thoracic central venous anatomy is not known.
  - **Type 1B: (B)** Unilateral IJV or SCV obstruction with patent ipsilateral BCV; patency of contralateral thoracic central venous anatomy is not known.
  - **Type 1C: (C)** Unilateral IJV or SCV obstruction with known patency of the contralateral IJV, SCV, and BCV.
  - **Type 1D: (D)** Bilateral obstruction of IJVs, SCVs, or combined IJV and SCVs, with both BCVs patent.
- **Type 2: (E, F)** Any form of TCVO that causes unilateral BCV obstruction or ipsilateral obstruction of the IJV and SCV (equivalent to unilateral BCV obstruction).
  - **Type 2A: (E)** Unilateral BCV obstruction with unknown condition of the contralateral side.
  - **Type 2B: (F)** Unilateral BCV obstruction with known patency of the contralateral side.
- **Type 3: (G)** Both BCVs are obstructed, but flow to the right atrium passes through the SVC.
- **Type 4: (H)** SVC obstruction that prevents or impedes direct thoracic venous flow to the right atrium with any constellation of BCV, IJV, or SCV obstruction.

TCVO: thoracic central vein obstruction; BCV: brachiocephalic vein; SCV: subclavian vein; IJV: internal jugular vein; SVC: superior vena cava.

Graphic 117576 Version 1.0

Magnetic resonance imaging (MRI) study demonstrating superior vena cava (SVC) invasion by lung carcinoma

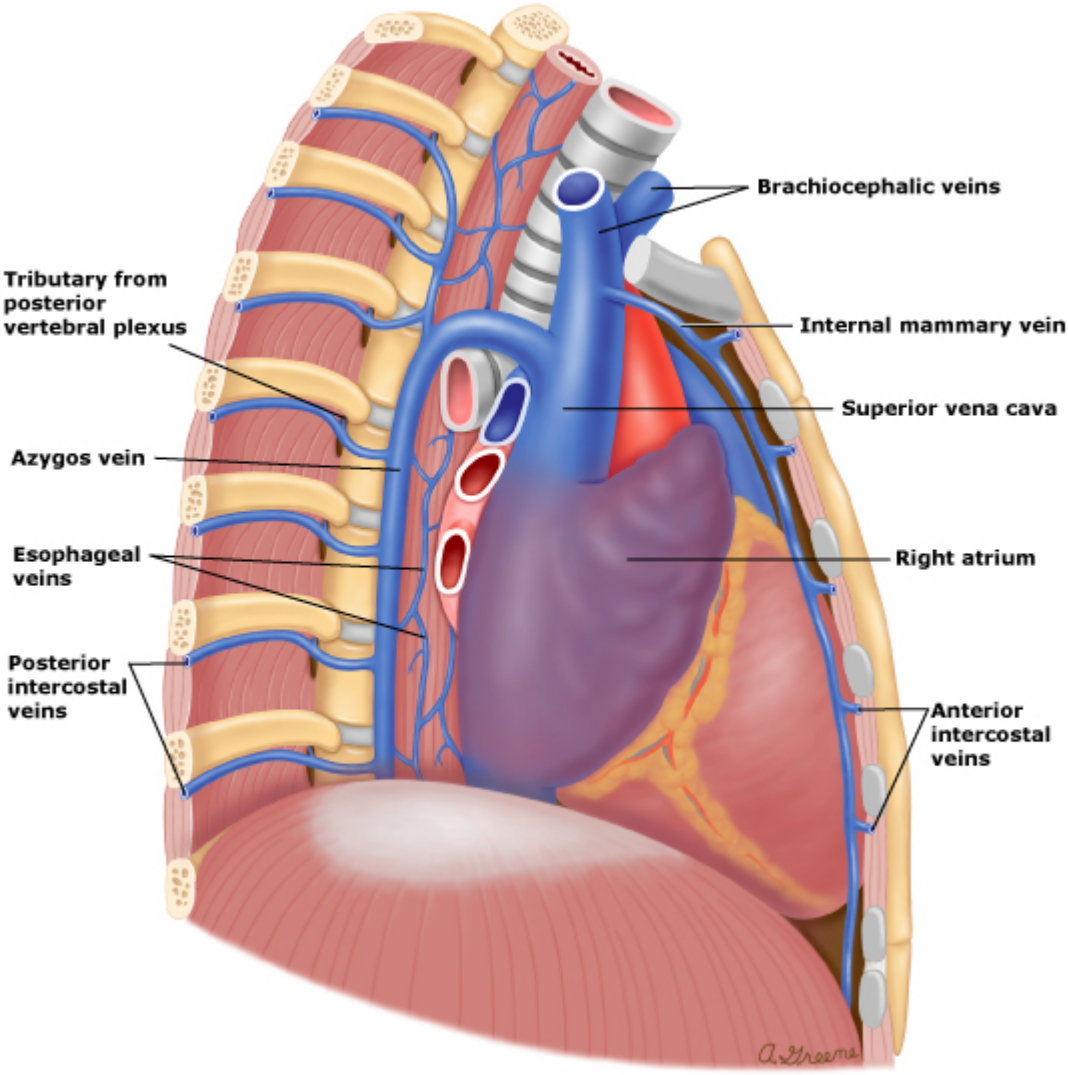


Gradient echo T1-weighted axial MRI image demonstrates a right paratracheal soft tissue mass that appears to invade or invaginate into the SVC, giving the appearance of an intraluminal mass (white arrow).

Courtesy of Paul Stark, MD.

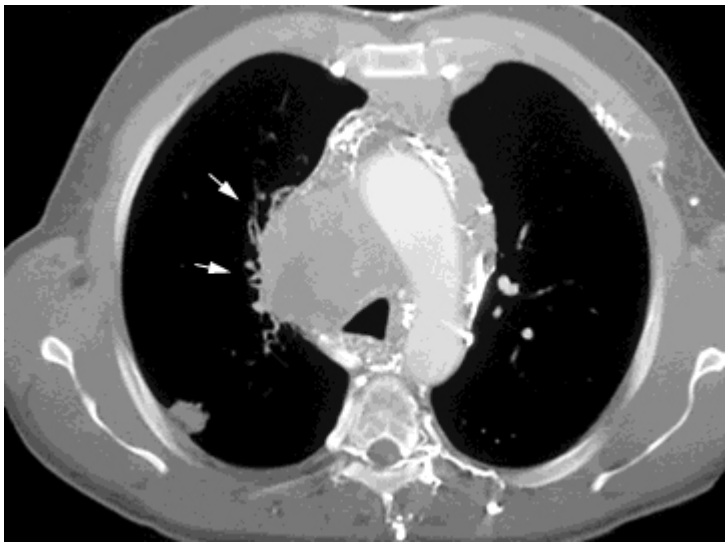
Graphic 56308 Version 3.0

Anatomy of the superior vena cava and veins of the mediastinum



Graphic 81142 Version 2.0

Superior vena cava syndrome from small cell lung carcinoma

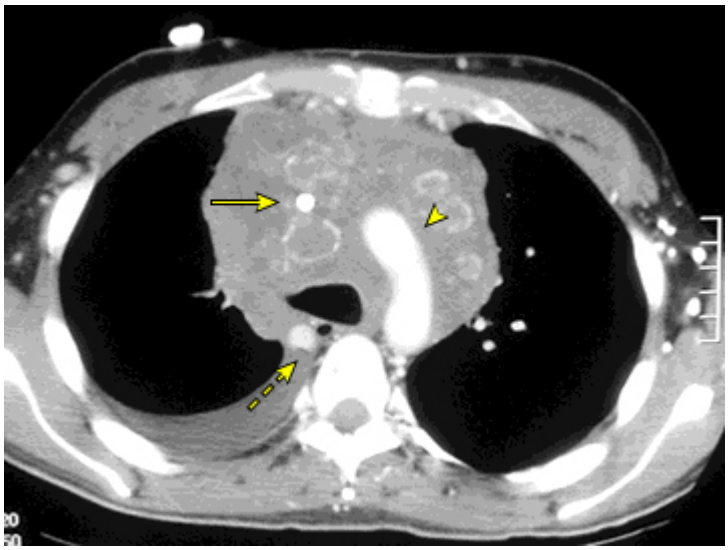


A peripheral nodule is visible in the posterior segment of the right upper lobe with adjacent large right paratracheal lymph nodes (white arrows) completely occluding the superior vena cava. Collateral vessels drain the contrast-enhanced venous blood towards the inferior vena cava. The internal mammary veins, the left superior intercostal vein, the lateral thoracic vein and the paravertebral veins are clearly visible.

Courtesy of Paul Stark, MD.

Graphic 70515 Version 3.0

Superior vena cava syndrome in a patient with lymphoma



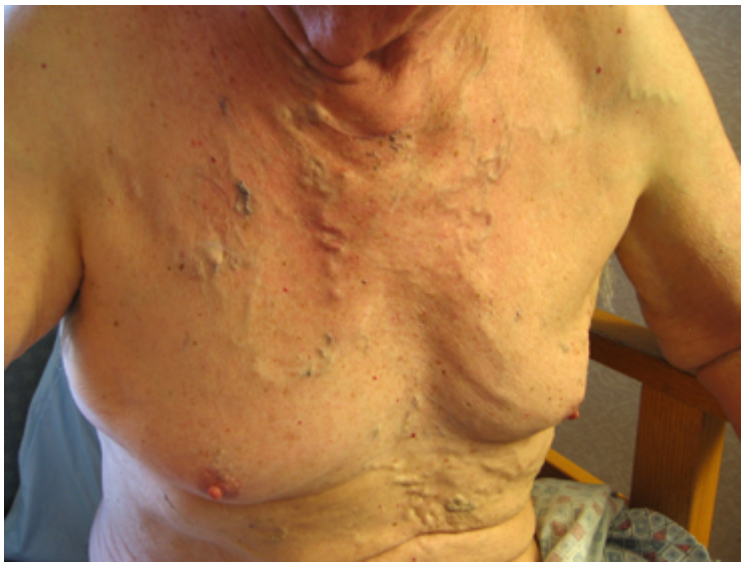
Axial CT scan image of a patient with non-Hodgkin's lymphoma and massive mediastinal lymph node enlargement. The superior vena cava is occluded and kept open by a Porta-A Cath (arrow). The lymphomatous mass encases the aortic arch (arrowhead) and displaces the trachea posteriorly. The azygos vein (dashed arrow) and the left lateral thoracic veins are dilated and enhancing. A right pleural effusion is visible. Of note, ring-like dystrophic calcifications are seen in the lymphomatous mass.

CT: computed tomography.

Courtesy of Paul Stark, MD.

Graphic 59806 Version 4.0

Superficial venous collateral veins in superior vena cava syndrome



A 65-year-old male smoker presented with non-productive cough, fatigue, worsening dyspnea on exertion, hoarseness, and a six-month history of progressively enlarging veins over the anterior chest wall. Chest imaging study showed a right-sided superior sulcus (Pancoast) tumor that was compressing the superior vena cava with a serpentine-shaped posterior extension impinging upon the sympathetic chain, phrenic nerve (impairing diaphragmatic motility contributing to the dyspnea), and recurrent laryngeal nerve. Biopsy confirmed a bronchogenic adenocarcinoma.

Courtesy of Vaibhav Parekh, MD, MBA.

Graphic 76917 Version 6.0

Grading the severity of malignant superior vena cava syndrome

Grade	Findings	Estimated incidence (%)
0	Asymptomatic – Radiographic superior vena cava obstruction in the absence of symptoms	10
1	Mild – Edema in head or neck (vascular distention), cyanosis, plethora	25
2	Moderate – Edema in head or neck with functional impairment (mild dysphagia, cough, mild or moderate impairment of head, jaw, or eyelid movements, visual disturbances caused by ocular edema)	50
3	Severe – Mild or moderate cerebral edema (headache, dizziness), mild/moderate laryngeal edema, or diminished cardiac reserve (syncope after bending)	10
4	Life-threatening – Significant cerebral edema (confusion, obtundation), significant laryngeal edema (stridor), or significant hemodynamic compromise (syncope without precipitating factors, hypotension, renal insufficiency)	5
5	Fatal – Death	<1

Reproduced from: Yu JB, Wilson LD, Detterbeck FC. Superior vena cava syndrome--a proposed classification system and algorithm for management. J Thorac Oncol 2008; 3:811. Table used with the permission of Elsevier Inc. All rights reserved.

Graphic 117725 Version 1.0

NCI CTCAE v5.0 superior vena cava (SVC) syndrome

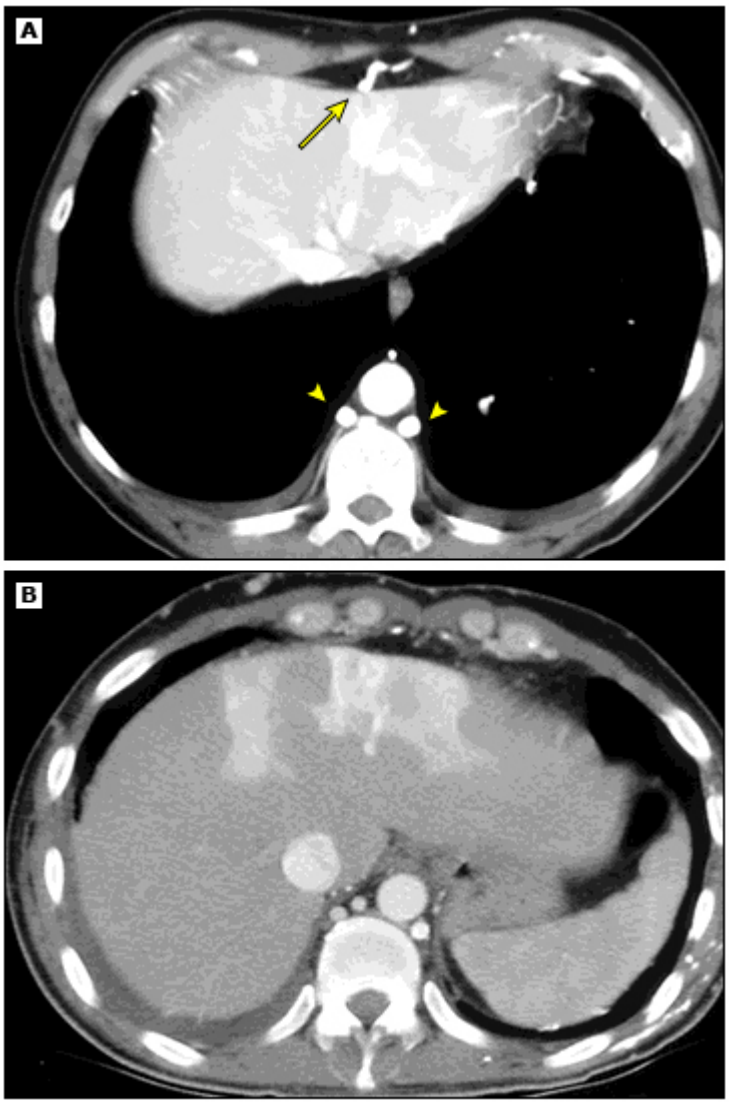
Adverse event	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
SVC syndrome	Asymptomatic; incidental finding of SVC thrombosis	Symptomatic, medical intervention indicated (eg, anticoagulation, radiation, or chemotherapy)	Severe symptoms; multimodality intervention indicated (eg, anticoagulation, chemotherapy, radiation, stenting)	Life-threatening consequences; urgent multimodality intervention indicated (eg, lysis, thrombectomy, surgery)	Death

SVC syndrome is characterized by obstruction of the blood flow in the SVC. Signs and symptoms include swelling and cyanosis of the face, neck, and upper arms, cough, orthopnea, and headache.

NCI CTCAE: National Cancer Institute Common Terminology Criteria for Adverse Events; SVC: superior vena cava.

Graphic 117316 Version 2.0

Collateral circulation from superior vena cava (SVC) syndrome falsely suggests a liver "hot spot"



(A) Contrast-enhanced axial CT image shows a dilated IM vein (arrow) connecting to the portal and hepatic venous circulation to eventually drain into the IVC. This process appears to form an enhancing liver "hot spot" that is actually draining venous blood from the obstructed SVC. Note also the dilated azygos and hemiazygos veins (arrowheads) that connect to the ascending lumbar veins and IVC.

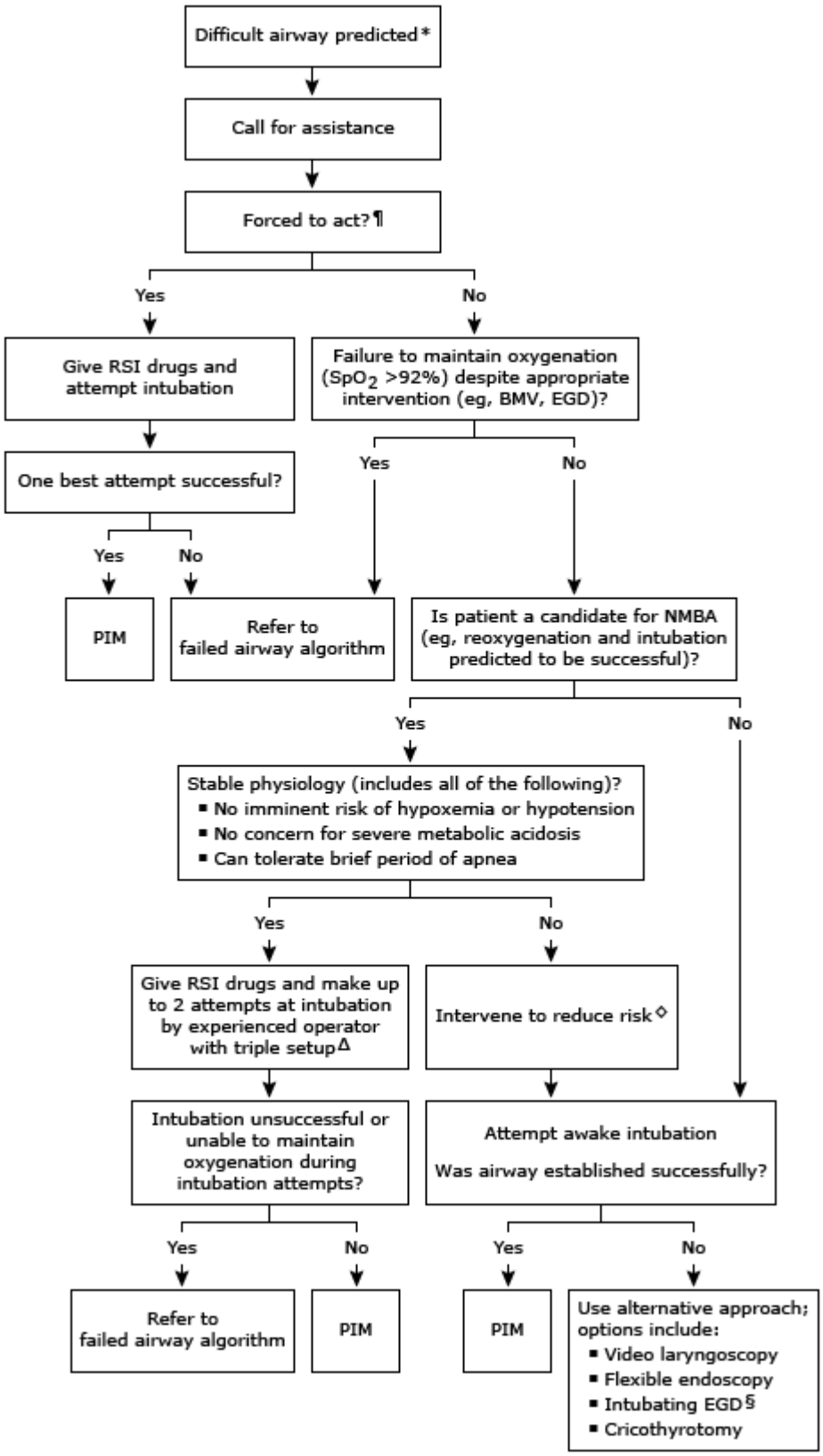
(B) Axial image at the level of the liver shows segmental enhancement of parts of the right and left lobes due to collateral flow from the IM vein.

CT: computed tomography; IM: internal mammary; IVC: inferior vena cava.

Courtesy of Paul Stark, MD.

Graphic 75771 Version 7.0

Difficult emergency airway management algorithm



RSI: rapid sequence intubation; SpO_2: oxygen saturation; PIM: post-intubation management; BMV: bag-mask ventilation; EGD: extraglottic airway device; NMBA: neuromuscular blocking agent.

* Predicting the difficult airway is discussed in the UpToDate topic and includes assessment tools such as the LEMON mnemonic.

¶ This situation is further discussed in the UpToDate topic and includes, for example, a patient who is agitated and unable to cooperate or a patient with rapidly progressing airway swelling.

Δ Triple setup implies a primary intubating plan is in place, followed by a nonsurgical rescue device (eg, EGD), and lastly a surgical rescue plan (most often an open surgical bougie-assisted cricothyrotomy).

◇ During RSI, physiologic derangements such as hypotension and hypoxemia increase the risk of cardiovascular collapse during the peri-intubation period. Possible mitigating interventions include the following:

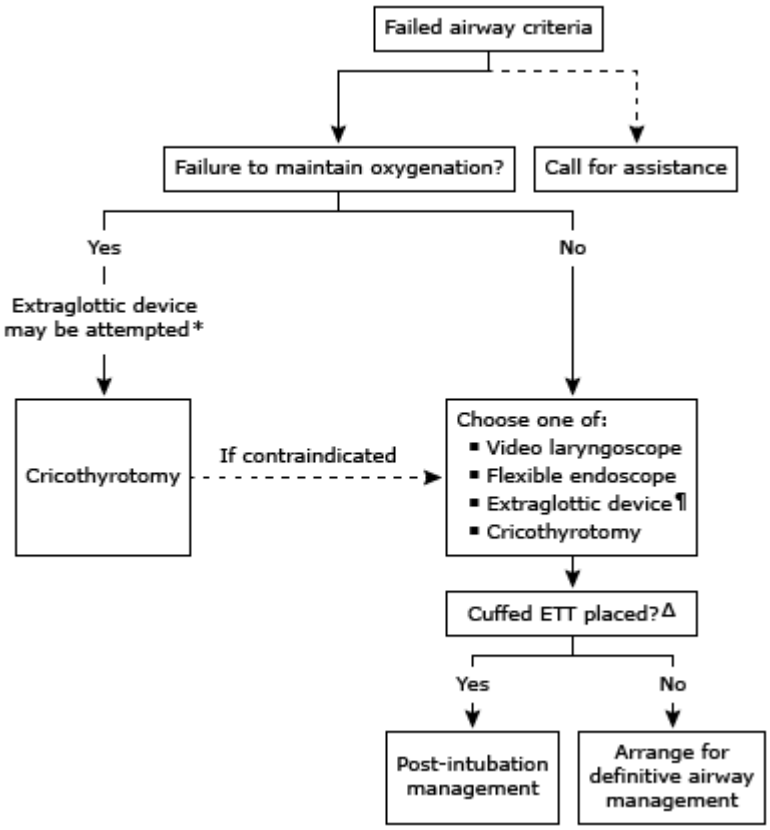
- In the hypotensive patient – An intravenous bolus of isotonic fluid and push-dose vasopressors.
- In the hypoxemic patient – Administration of high-flow oxygen and apneic oxygenation.
- In the patient with severe metabolic acidosis – Treat the underlying etiology and perform awake technique if period of apnea contraindicated.

Please refer to UpToDate topics on RSI for further detail.

§ The minimum age/weight limit for an intubating EGD is 12 yrs/30 kg.

Graphic 140479 Version 3.0

Failed airway algorithm



ETT: endotracheal tube.

* Should a surgical airway be needed in these circumstances, 1 attempt at tracheal intubation using video or direct laryngoscopy may be performed, provided preparations for a surgical airway occur simultaneously.

¶ Placement of an extraglottic device is contraindicated in the setting of severe hypopharyngeal pathology, such as epiglottitis.

Δ In neonates, a cuffed ETT is suggested, but an uncuffed endotracheal tube is acceptable.

Graphic 73112 Version 24.0

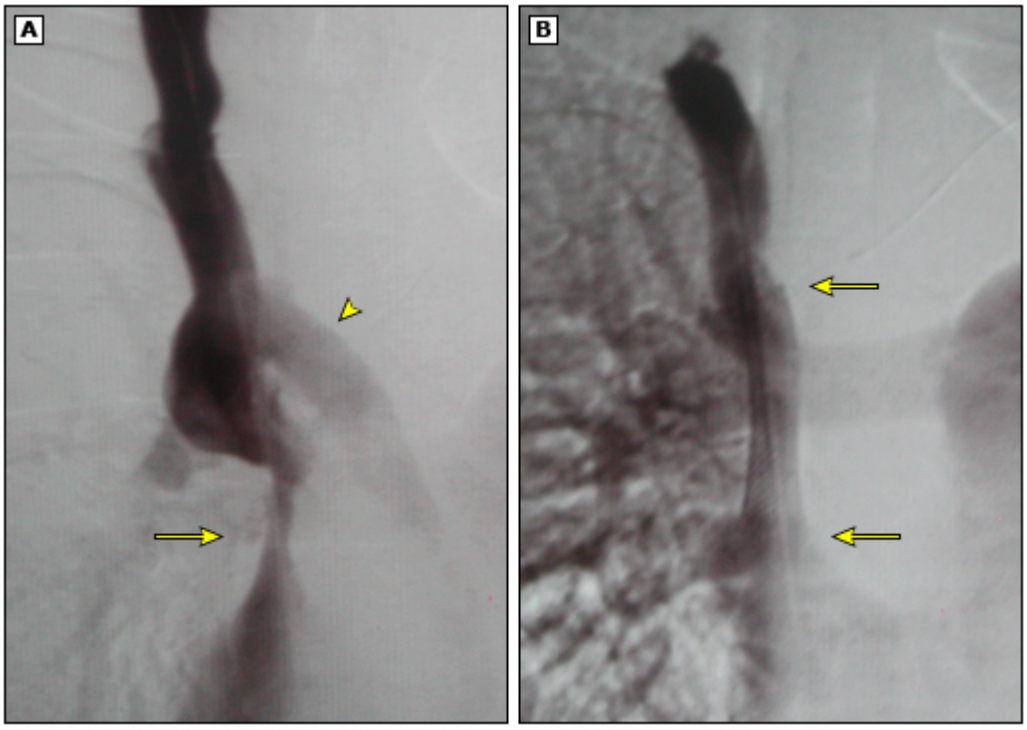
Contraindications to fibrinolytic therapy for deep venous thrombosis or acute pulmonary embolism

Absolute contraindications
▪ Prior intracranial hemorrhage ▪ Known structural cerebral vascular lesion ▪ Known malignant intracranial neoplasm ▪ Ischemic stroke within 3 months (excluding stroke within 3 hours*) ▪ Suspected aortic dissection ▪ Active bleeding or bleeding diathesis (excluding menses) ▪ Significant closed-head trauma or facial trauma within 3 months
Relative contraindications
▪ History of chronic, severe, poorly controlled hypertension ▪ Severe uncontrolled hypertension on presentation (SBP >180 mmHg or DBP >110 mmHg) ▪ History of ischemic stroke >3 months prior ▪ Traumatic or prolonged (>10 minutes) CPR or major surgery <3 weeks ▪ Recent (within 2 to 4 weeks) internal bleeding ▪ Noncompressible vascular punctures ▪ Recent invasive procedure ▪ For streptokinase/anistreplase – Prior exposure (>5 days ago) or prior allergic reaction to these agents ▪ Pregnancy ▪ Active peptic ulcer ▪ Pericarditis or pericardial fluid ▪ Current use of anticoagulant (eg, warfarin sodium) that has produced an elevated INR >1.7 or PT >15 seconds ▪ Age >75 years ▪ Diabetic retinopathy

SBP: systolic blood pressure; DBP: diastolic blood pressure; CPR: cardiopulmonary resuscitation; INR: international normalized ratio; PT: prothrombin time.

* The American College of Cardiology suggests that select patients with stroke may benefit from thrombolytic therapy within 4.5 hours of the onset of symptoms.

Superior vena cava (SVC) stenting for SVC syndrome



(A) The venogram shows tight stenosis of the SVC (arrow). Flow in the markedly dilated azygos vein is reversed (arrowhead) due to obstruction of the SVC.

(B) Venogram after stent placement: There is good flow in the SVC within the stent (between the arrows), and the azygos vein is no longer opacified due to normalization of flow towards the SVC.

Courtesy of Dmitry Rabkin, MD, PhD.

Graphic 69106 Version 4.0

Contributor Disclosures

Reed E Drews, MD No relevant financial relationship(s) with ineligible companies to disclose. **Dmitry J Rabkin, MD, PhD** Consultant/Advisory Boards: Microbot Medical [Endovascular robots]. All of the relevant financial relationships listed have been mitigated. **Eduardo Bruera, MD** No relevant financial relationship(s) with ineligible companies to disclose. **John F Eidt, MD** Grant/Research/Clinical Trial Support: Syntactx [Clinical events and data/safety monitoring for medical device trials]. All of the relevant financial relationships listed have been mitigated. **Joseph L Mills, Sr, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Nestor L Muller, MD, PhD** No relevant financial relationship(s) with ineligible companies to disclose. **Sadhna R Vora, MD** No relevant financial relationship(s) with ineligible companies to disclose. **Kathryn A Collins, MD, PhD, FACS** No relevant financial relationship(s) with ineligible companies to disclose.

Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

Conflict of interest policy

→