Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Joffe HV, Kucher N, Tapson VF, Goldhaber SZ. Upper-extremity deep vein thrombosis: a prospective registry of 592 patients. *Circulation.* 2004;110(12):1605-1611.	Observational-Dx	5,388 patients	To improve the understanding of UEDVT, the authors compared the demographics, symptoms, risk factors, prophylaxis, and initial management of 324 (6%) patients with CVC-associated UEDVT, 268 (5%) patients with non-CVC-associated UEDVT, and 4,796 (89%) patients with lower-extremity DVT from a prospective U.S. multicenter DVT registry.	The authors determined that an indwelling CVC was the strongest independent predictor of UEDVT (OR, 7.3; 95% CI, 5.8 to 9.2). An age of <67 years, a body mass index of <25 kg/m2, and hospitalization were the independent predictors of non-CVC-associated UEDVT. Most (68%) UEDVT patients were evaluated while they were inpatients. Only 20% of the 378 UEDVT patients who did not have an obvious contraindication to anticoagulation received prophylaxis at the time of diagnosis. UEDVT risk factors differ from the conventional risk factors for lower-extremity DVT. The findings identify deficiencies in the current understanding and the prophylaxis of UEDVT and generate hypotheses for future research efforts.	3
2. Kucher N. Clinical practice. Deep-vein thrombosis of the upper extremities. *N Engl J Med.* 2011;364(9):861-869.	Review/Other-Dx	N/A	A review on DVT of the upper extremities.	No results stated in abstract.	4
3. Abdullah BJ, Mohammad N, Sangkar JV, et al. Incidence of upper limb venous thrombosis associated with peripherally inserted central catheters (PICC). *Br J Radiol.* 2005;78(931):596-600.	Review/Other-Dx	26 patients	To prospectively determine the incidence of venous thrombosis in the upper limbs in patients with PICC.	No statistical correlation between the site of insertion of the PICC and the location of venous thrombosis. No observed correlation between the occurrence of venous thrombosis with the patient's history of hypertension, hypercholesterolaemia, coronary artery disease, diabetes mellitus, cardiac insufficiency, smoking or cancer. No statistical correlation with the size of the catheter. PICC are associated with a significant risk of UEDVT.	4
4. Knudson GJ, Wiedmeyer DA, Erickson SJ, et al. Color Doppler sonographic imaging in the assessment of upper-extremity deep venous thrombosis. *AJR Am J Roentgenol.* 1990;154(2):399-403.	Observational-Dx	91 patients 130 extremities	To determine the accuracy of color Doppler flow imaging in the assessment of UEDVT.	Sensitivity of the Doppler studies was 78% and the specificity was 92%. Color Doppler flow imaging is an accurate, noninvasive method for the evaluation of UEDVT. Other imaging tests may be required when the color Doppler study is negative and central venous thrombosis is suspected.	3

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5. Mustafa S, Stein PD, Patel KC, Otten TR, Holmes R, Silbergleit A. Upper extremity deep venous thrombosis. *Chest.* 2003;123(6):1953-1956.	Review/Other-Dx	44,136 patients	Retrospective review to determine the prevalence of symptomatic UEDVT and its association with symptomatic acute PE in a community teaching hospital.	Symptomatic UEDVT was diagnosed in 65/44,136 patients of all ages (0.15%) [or 64/34,567 adult patients ≥20 years of age; 0.19%]. In 7 patients, the UEDVT was shown by venography to extend proximally to the brachiocephalic vein. Among these, the DVT extended to the superior vena cava in 2 patients. All of the patients received anticoagulant therapy for UEDVT. No patients developed symptomatic PE. Central lines at the site of the UEDVT were inserted in 39/65 patients (60%). Cancer was diagnosed in 30/65 patients (46%), 23 cancer patients also had central lines, and 19 patients (29%) had UEDVT with no apparent cause. All patients had swelling of the upper extremities. Erythema over the affected site was present in 4 patients (6%). Pain was present in 26 patients (40%), although some discomfort due to swelling was present in all patients.	4
6. Patel MC, Berman LH, Moss HA, McPherson SJ. Subclavian and internal jugular veins at Doppler US: abnormal cardiac pulsatility and respiratory phasicity as a predictor of complete central occlusion. *Radiology.* 1999;211(2):579-583.	Observational-Dx	21 consecutive patients	To analyze changes in venous Doppler waveforms of damped or diminished cardiac pulsatility and respiratory phasicity. US findings were compared with phlebographic findings.	US can be used to establish the presence or absence of thrombosis in the distal portion of the brachiocephalic or subclavian veins, which are inaccessible to direct insonation.	3
7. Schmittling ZC, McLafferty RB, Bohannon WT, Ramsey DE, Hodgson KJ. Characterization and probability of upper extremity deep venous thrombosis. *Ann Vasc Surg.* 2004;18(5):552-557.	Review/Other-Dx	177 upper extremities of arms	Retrospective review of patients who underwent color-flow duplex scanning for clinically suspected acute UEDVT. To characterize patient demographics, risk factors, and anatomic distribution of UEDVT to develop a probability model for diagnosis.	Color-flow duplex scanning identified acute UEDVT in 53 (30%) of the arms examined with deep system involvement in 40 (23%). Of the upper extremities affected, the subclavian was involved in 64%, the axillary in 25%, the internal jugular in 32%, the brachial in 36%, the cephalic in 32%, and the basilic in 47%. Use of this model can help focus clinical suspicion, improve color-flow duplex utilization, and provide timely treatment with anticoagulation.	4

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8. Spencer FA, Emery C, Lessard D, Goldberg RJ. Upper extremity deep vein thrombosis: a community-based perspective. *Am J Med.* 2007;120(8):678-684.	Review/Other-Dx	483 patients 69 with UEDVT	Review medical records to examine the magnitude, risk factors, management strategies, and outcomes in a population-based investigation of patients with upper, as compared with lower, extremity DVT diagnosed in 1999.	Patients with UEDVT represent a clinically important patient population in the community setting. Risk factors, occurrence of PE, and timing and location of venous thromboembolism recurrence differ between patients with upper as compared with lower extremity DVT.	4
9. Lee AY, Levine MN, Butler G, et al. Incidence, risk factors, and outcomes of catheter-related thrombosis in adult patients with cancer. *J Clin Oncol.* 2006;24(9):1404-1408.	Review/Other-Dx	444 patients	To examine the incidence, risk factors, and long-term complications of symptomatic CRT in adults with cancer.	Over 76,713 patient-days of follow-up, 19/444 patients (4.3%) had symptomatic CRT in 19/500 catheters (0.3 per 1,000 catheter-days). The median time to CRT was 30 days and the median catheter life span was 88 days. Significant baseline risk factors for CRT were: more than 1 insertion attempt (OR = 5.5; 95% CI, 1.2 to 24.6; *P*=.03); ovarian cancer (OR = 4.8; 95% CI, 1.5 to 15.1; *P*=.01); and previous CVC insertion (OR = 3.8; 95% CI, 1.4 to 10.4; *P*=.01). 9/19 CRT patients were treated with anticoagulants alone, 8 patients were treated with anticoagulants and catheter removal, while 2 patients did not receive anticoagulation. None had recurrent CRT or symptomatic PE. Postphlebitic symptoms were infrequent.	4
10. Baarslag HJ, Koopman MM, Reekers JA, van Beek EJ. Diagnosis and management of deep vein thrombosis of the upper extremity: a review. *Eur Radiol.* 2004;14(7):1263-1274.	Review/Other-Dx	N/A	To describe the clinical background, the imaging modalities that may be employed, treatment options and outcome of patients with UEDVT.	No results stated in abstract.	4
11. Baarslag HJ, van Beek EJ, Koopman MM, Reekers JA. Prospective study of color duplex ultrasonography compared with contrast venography in patients suspected of having deep venous thrombosis of the upper extremities. *Ann Intern Med.* 2002;136(12):865-872.	Observational-Dx	126 consecutive patients	Prospective study of duplex US compared with venography to determine the accuracy of duplex US for diagnosis of UEDVT.	Sensitivity and specificity of duplex US and venography were 82% (95% CI, 70% to 93%) and 82% (CI, 72% to 92%), respectively. Duplex US may be the method of choice for initial diagnosis of patients with suspected UEDVT. However, in patients with isolated flow abnormalities, contrast venography should be performed.	1

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12. Ong B, Gibbs H, Catchpole I, Hetherington R, Harper J. Peripherally inserted central catheters and upper extremity deep vein thrombosis. *Australas Radiol*. 2006;50(5):451-454.	Review/Other-Dx	317 scans 115 positive for UEDVT	Retrospective study of all UEDVT duplex scans was carried out to determine the incidence and risk factors for venous thrombosis in patients with a PICC.	Three main risk factors identified were; presence of a central line, malignancy and administration of chemotherapy. PICC were the most common central line present. Symptomatic thrombosis occurred in 7% of PICC inserted for chemotherapy compared with 1% of PICC inserted for other reasons.	4
13. Prandoni P, Polistena P, Bernardi E, et al. Upper-extremity deep vein thrombosis. Risk factors, diagnosis, and complications. *Arch Intern Med*. 1997;157(1):57-62.	Observational-Dx	58 consecutive patients	To identify the clinical and laboratory parameters associated with UEDVT, to assess the diagnostic accuracy of US methods for its detection, and to establish the frequency of both early and late complications.	CVCs, thrombophilic states, and a previous leg vein thrombosis were statistically significantly associated with UEDVT. Sensitivity and specificity of compression US (96% and 93.5%, respectively) and color flow Doppler imaging (100% and 93%, respectively) were comparable and better than those of Doppler US (81% and 77%, respectively). Objective findings suggestive of a PE were recorded in 36% of the patients with UEDVT. After a mean follow-up of 2 years, 2 patients with UEDVT experienced recurrent thromboembolic events, and 4 had post-thrombotic sequelae.	1
14. Flinterman LE, van Hylckama Vlieg A, Rosendaal FR, Doggen CJ. Venous thrombosis of the upper extremity: effect of blood group and coagulation factor levels on risk. *Br J Haematol*. 2010;149(1):118-123.	Observational-Dx	5,000 patients	To investigate the effect of coagulation factors on risk of UEDVT.	OR were estimated for elevated levels of factor II, VII, VIII, IX, X, XI, von Willebrand Factor, and fibrinogen, low levels of protein C, protein S, and antithrombin, and for blood group non-O. Substantially increased risks of UEDVT were found for patients with high levels (above 90th percentile vs below) of factor VIII (OR: 4.2, 95% CI: 2.2–7.9), von Willebrand Factor (OR: 4.0, 95% CI: 2.1–7.8), fibrinogen (OR: 2.9, 95% CI, 1.5–5.7), and for blood group non-O compared to O (OR: 2.1, 95% CI, 1.3–3.6). The other factors were not associated with an increased risk. Elevated levels of several procoagulant factors are associated with a strongly increased risk of UEDVT.	3

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15. Mai C, Hunt D. Upper-extremity deep venous thrombosis: a review. *Am J Med*. 2011;124(5):402-407.	Review/Other-Dx	N/A	To differentiate between primary and secondary UEDVT; assess the risk factors and clinical sequelae associated with UEDVT, comparing these with lower-extremity DVT; and describe an approach to treatment and prevention of secondary UEDVT based on clinical evidence.	No results stated in abstract.	4
16. Lam EY, Giswold ME, Moneta GL. Venous and Lymphatic Disease. In: Brunicardi FC, Andersen DK, Billiar TR, et al., eds. *Schwartz's Principles of Surgery*. 8th ed: McGraw-Hill; 2005.	Review/Other-Dx	N/A	Book chapter.	N/A	4
17. Agarwal AK, Patel BM, Haddad NJ. Central vein stenosis: a nephrologist's perspective. *Semin Dial*. 2007;20(1):53-62.	Review/Other-Tx	N/A	A review on central vein stenosis.	No results stated in abstract.	4
18. Hingorani AP, Ascher E, Markevich N, et al. Prospective evaluation of combined upper and lower extremity DVT. *Vasc Endovascular Surg*. 2006;40(2):131-134.	Observational-Dx	227 patients	Prospective study to evaluate combined upper and lower extremity DVT.	211 (93%) of 227 patients had lower extremity studies; 45 of these 211 (21%) had acute lower extremity DVT by duplex examination in addition to the UEDVT. 22/211 patients had bilateral lower extremity DVT, and 8 patients were found to have chronic thrombosis of lower extremity veins. Of the patients with bilateral UEDVT, there were 3 with bilateral lower extremity acute DVT. Finally, 8 of the remaining 166 patients (5%) with originally negative lower extremity studies were found to develop a thrombosis at a later date.	4

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19. Constans J, Salmi LR, Sevestre-Pietri MA, et al. A clinical prediction score for upper extremity deep venous thrombosis. *Thromb Haemost.* 2008;99(1):202-207.	Observational-Dx	140 patients	To design a clinical prediction score for the diagnosis of UEDVT.	The clinical score identified a combination of 4 items (venous material, localized pain, unilateral pitting edema and other diagnosis as plausible). One point was attributed to each item (positive for the first 3 and negative for the other diagnosis). A score of -1 or 0 characterized low probability patients, a score of 1 identified intermediate probability patients, and a score of 2 or 3 identified patients with high probability. Low probability score identified a prevalence of UEDVT of 12%, 9% and 13%, respectively, in the derivation, validation and OPTIMEV samples. High probability score identified a prevalence of UEDVT of 70%, 64% and 69% respectively.	3
20. Merminod T, Pellicciotta S, Bounameaux H. Limited usefulness of D-dimer in suspected deep vein thrombosis of the upper extremities. *Blood Coagul Fibrinolysis.* 2006;17(3):225-226.	Observational-Dx	52 consecutive patients	To provide preliminary data on the potential role of D-dimer testing in clinically suspected UEDVT.	UEDVT diagnosed in 15 patients (29%). Sensitivity and specificity of D-dimer for the presence of UEDVT, using a diagnostic cutoff value of 500 mg/l, were 100% (95% CI, 78–100) and 14% (95% CI, 4–29), respectively, resulting in PPV and NPV of 32% (95% CI, 19–47) and 100% (95% CI, 47–100), respectively. Results suggest both a high sensitivity and a low specificity of D-dimer in clinically suspected UEDVT, casting doubt about the usefulness of the test in the diagnostic management of this condition. The usefulness of the test in subgroups of patients with suspected UEDVT should be studied in especially designed trials.	3

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21. Di Nisio M, Van Sluis GL, Bossuyt PM, Buller HR, Porreca E, Rutjes AW. Accuracy of diagnostic tests for clinically suspected upper extremity deep vein thrombosis: a systematic review. *J Thromb Haemost.* 2010;8(4):684-692.	Review/Other-Dx	17 articles with 793 patients; 2 independent reviewers	Systematic review was performed to assess whether the diagnostic accuracy of other tests for clinically suspected UEDVT is high enough to justify their use in clinical practice and to evaluate if any test can replace venography.	Sensitivity (95% CI) was 97% (90%–100%) for compression US, 84% (72%–97%) for Doppler US, 91% (85%–97%) for Doppler US with compression, and 85% (72%–99%) for phleboreography. The corresponding summary estimates of specificity were, respectively, 96% (87%–100%), 94% (86%–100%), 93% (80%–100%), and 87% (71%–100%). Clinical findings, a clinical score, D-dimer, MRI, rheography and plethysmography were evaluated in 1 study each, involving a median number of 46 patients (range 21–214). Sensitivity and specificity ranged from 0% to 100% and from 14% to 100%. Methodological limitations, large between-study differences and small sample sizes limit the evidence of tests for clinically suspected UEDVT. Compression US may be an acceptable alternative to venography. The addition of (color) Doppler does not seem to improve the accuracy. Adequately designed studies are warranted to confirm these findings.	4
22. Rondina MT, Lam UT, Pendleton RC, et al. (18)F-FDG PET in the evaluation of acuity of deep vein thrombosis. *Clin Nucl Med.* 2012;37(12):1139-1145.	Observational-Dx	12 patients; 24 controls	To examine the role of FDG PET in the evaluation of acute, proximal, symptomatic DVT. The primary hypothesis was that the metabolic activity of thrombosed vein segments would be significantly higher than nonthrombosed vein segments. The secondary hypothesis was that the metabolic activity of thrombosed vein segments would decrease with the time from DVT symptom onset.	The metabolic activity in thrombosed veins [SUVmax, 2.41 (0.75)] was visually appreciable and significantly higher than in nonthrombosed veins in either the contralateral extremity of patients with DVT [SUVmax, 1.09 (0.25), $P=0.007$] or control subjects [1.21 (0.22), $P<0.001$]. The area under the receiver operating characteristic curve for SUVmax was 0.9773 ($P<0.001$), indicating excellent accuracy. An SUVmax threshold of >1.645 was 87.5% sensitive and 100% specific for DVT. Metabolic activity in thrombosed veins correlated significantly with time from DVT symptom onset (decrease in SUVmax of 0.02/d, $P<0.05$). Best-fit-line analyses suggested that approximately 84 to 91 days after acute DVT, the maximum metabolic activity of thrombosed veins would return to normal levels.	3

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23. Do B, Mari C, Biswal S, Kalinyak J, Quon A, Gambhir SS. Diagnosis of aseptic deep venous thrombosis of the upper extremity in a cancer patient using fluorine-18 fluorodeoxyglucose positron emission tomography/computerized tomography (FDG PET/CT). *Ann Nucl Med.* 2006;20(2):151-155.	Review/Other-Dx	1 patient	To describe a patient with a history of recurrent squamous cell carcinoma of the tongue and abnormal FDG uptake in the left arm during a re-staging FDG-PET/CT.	After revision of the patient's clinical history, tests and physical examination, the abnormal FDG uptake was found to correspond to an extensive aseptic UEDVT.	4
24. Gloviczki P, Calcagno D, Schirger A, et al. Noninvasive evaluation of the swollen extremity: experiences with 190 lymphoscintigraphic examinations. *J Vasc Surg.* 1989;9(5):683-689; discussion 690.	Observational-Dx	115 patients; 190 extremities	Lymphoscintigraphy performed with Tc-99m labeled antimony trisulfide colloid was used as a noninvasive diagnostic examination to evaluate the lymphatic circulation in extremities.	Semiquantitative evaluation of the lymphatic drainage and visual interpretation of the image patterns were reliable to differentiate lymphedema from edemas of other origin (sensitivity: 92%, specificity: 100%). Lymphoscintigraphy is safe and reliable and has no side effects. It should replace contrast lymphangiography in the routine evaluation of the swollen extremity.	4
25. Sharif-Kashani B, Behzadnia N, Shahabi P, Sadr M. Screening for deep vein thrombosis in asymptomatic high-risk patients: a comparison between digital photoplethysmography and venous ultrasonography. *Angiology.* 2009;60(3):301-307.	Observational-Dx	337 limbs in 169 patients	Prospective study to determine the role of digital photoplethysmography in screening asymptomatic patients who are susceptible for developing DVT. Patients at high risk for development of DVT were assessed by US digital photoplethysmography and the results were compared.	13 limbs were found to have DVT as demonstrated by US. All limbs with a venous refilling time greater than 12 seconds had a normal US. Compared with US and using refilling time less than 12 seconds as the cutoff point, digital photoplethysmography achieved a sensitivity, specificity, PPV, and NPV of 100%, 73.8%, 13.3%, and 100% respectively, for detecting DVT in asymptomatic high-risk patients. Digital photoplethysmography is a simple, noninvasive, and highly sensitive test for screening of DVT.	2
26. Wang YF, Cherng SC, Chiu JS, Su YC, Sheu YT. Application of upper extremity radionuclide venography as a diagnostic approach for Port-A catheter thrombosis. *J Chin Med Assoc.* 2006;69(8):358-363.	Review/Other-Dx	14 symptomatic patients	To investigate the role of upper extremity radionuclide venography as a potential diagnostic modality in the assessment of venous thrombosis associated with a Port-A catheter.	The findings of the dynamic images demonstrated clinical problems. Three patients were free of a definite venous flow change. 3 patients had partial obstruction of venous return. A significant cut-off of venous return was demonstrated in 8 patients, and total occlusions were hence diagnosed. All patients underwent this procedure smoothly without any complication. Upper extremity radionuclide venography is an easily performed and effective method for diagnosing Port-A catheter thrombosis in clinical practice.	4

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27. Akita S, Mitsukawa N, Kazama T, et al. Comparison of lymphoscintigraphy and indocyanine green lymphography for the diagnosis of extremity lymphoedema. *J Plast Reconstr Aesthet Surg.* 2013;66(6):792-798.	Observational-Dx	169 limbs in 95 secondary patients and 65 limbs in 39 idiopathic patients	To compare the utility of lymphoscintigraphy and indocyanine green lymphography for patients with suspected extremity lymphoedema and for those in whom surgical treatment of lymphoedema was under consideration.	In secondary oedema, the sensitivity of indocyanine green lymphography, compared with lymphoscintigraphy, was 0.972, the specificity was 0.548 and the accuracy was 0.816. When patients with lymphoscintigraphy type I and indocyanine green lymphography stage I were regarded as negative, the sensitivity of the indocyanine green lymphography was 0.978, the specificity was 0.925 and the accuracy was 0.953. There was a significant positive correlation between the lymphoscintigraphy type and the indocyanine green lymphography stage. In idiopathic oedema, the sensitivity of indocyanine green lymphography was 0.974, the specificity was 0.778 and the accuracy was 0.892.	3
28. Infante JR, Garcia L, Laguna P, et al. Lymphoscintigraphy for differential diagnosis of peripheral edema: diagnostic yield of different scintigraphic patterns. *Rev Esp Med Nucl Imagen Mol.* 2012;31(5):237-242.	Observational-Dx	61 patients	To evaluate the usefulness of radionuclide studies in the differential diagnosis of edema, and the diagnostic yield of different scintigraphic patterns.	The best diagnostic yield was achieved by considering dermal backflow and asymmetry in inguinal/axillary nodes (accuracy 88.9%, specificity 96.4%, and PPV 95.5%). Evaluation of intermediate lymph nodes and presence of collateral pathways contributed little to the diagnostic yield, showing poor sensitivity and high false positive rates.	3

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29. Raju S, Furrh JBt, Neglen P. Diagnosis and treatment of venous lymphedema. *J Vasc Surg.* 2012;55(1):141-149.	Observational-Dx	443 CEAP C(3) limbs	To show that (1) routine use of intravascular US can detect venous obstruction missed by traditional venous testing, and (2) iliac-caval venous stenting can yield satisfactory clinical relief and can sometimes reverse abnormal lymphangiographic findings.	Clinical features were a poor guide to the diagnosis of lymphedema. Isotope lymphangiography was not helpful in differentiating primary from secondary lymphedema. Venography had 61% sensitivity to the diagnosis of venous obstruction. Intravascular US had a sensitivity of 88% for significant (≥50% area stenosis) venous obstruction. At 40 months, cumulative secondary stent patency was similar for the abnormal (100%) and normal lymphangiographic (95%) groups. Swelling improved significantly after stent placement in the abnormal lymphangiographic group (mean [standard deviation] swelling grade improvement 0.8 +/- 1.1) but was less (P<.004) than in the control group (1.4 +/- 1.3). Complete swelling relief was 16% and 44% (P<.001) and partial improvement (≥1 grade of swelling) was 45% and 66% (P<.01) in the abnormal and normal lymphangiographic groups, respectively. Associated pain was present in 50% and 36% of the swollen limbs in the abnormal and normal lymphangiographic groups. Pain relief (≥3 visual analog scale) at 40 months was 87% and 83%, respectively (P = .3), with 65% and 71%, experiencing complete pain relief. Quality of life criteria improved after stent placement in both groups but to a better extent in the normal lymphangiographic group. Abnormal lymphangiography improved or normalized in 9/36 (25%) of those tested after stent correction.	3

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30. Liu NF, Yan ZX, Wu XF. Classification of lymphatic-system malformations in primary lymphoedema based on MR lymphangiography. *Eur J Vasc Endovasc Surg.* 2012;44(3):345-349.	Review/Other-Dx	378 patients	To investigate lymphatic-system malformations and propose a classification of primary lymphoedema based on comprehensive imaging data of both lymph vessel- and lymph-node abnormalities.	A total of 63 (17%) patients exhibited defects of the inguinal lymph nodes with mild or moderate dilatation of afferent lymph vessels. A total of 123 (32%) patients exhibited lymphatic anomalies as lymphatic aplasia, hypoplasia or hyperplasia with no obvious defect of the drainage lymph nodes. The involvement of both lymph vessel- and lymph-node abnormalities in the affected limb was found in 192 (51%) patients. The primary lymphoedema was classified as 3 major types as: (1) lymph nodes affected only; (2) lymph vessel affected only with 3 subtypes and (3) both lymph vessel and lymph node affected with subgroups.	4
31. Notohamiprodjo M, Weiss M, Baumeister RG, et al. MR lymphangiography at 3.0 T: correlation with lymphoscintigraphy. *Radiology.* 2012;264(1):78-87.	Observational-Dx	30 patients	To prospectively compare findings of MR lymphangiography with those of lymphoscintigraphy, evaluate the pattern and delay of lymphatic drainage, compare typical findings, and investigate discrepancies between the techniques.	Weak lymphatic drainage at lymphoscintigraphy correlated with lymphangiectasia at MR lymphangiography (13/33 affected extremities). Lymph vessels were clearly visualized with MR lymphangiography (5/24 affected extremities), while they were not detectable with lymphoscintigraphy. Depiction of inguinal lymph nodes was clearer with lymphoscintigraphy (5/60 extremities). Correlation of both techniques was excellent for delay (kappa=0.93) and pattern (kappa=0.84) of drainage, good for depiction of lymph nodes (kappa=0.67) and number of enhancing levels (kappa=0.77), and moderate for depiction of lymph vessels (kappa=0.50). Sensitivity and specificity for delay and pattern of drainage were concordant, whereas MR lymphangiography showed a higher sensitivity for lymph vessel abnormalities (100% vs 79%) and lower specificity for lymph node abnormalities (78% vs 100%).	2

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32. Baxter GM, Kincaid W, Jeffrey RF, Millar GM, Porteous C, Morley P. Comparison of colour Doppler ultrasound with venography in the diagnosis of axillary and subclavian vein thrombosis. *Br J Radiol*. 1991;64(765):777-781.	Observational-Dx	19 patients (30 limbs)	Prospective study to compare bilateral venography with US for detection of DVT in the upper venous system in children with acute lymphoblastic leukemia.	DVT occurred in 29% (19/66) patients. While 15/19 DVT were detected by venography (sensitivity 79%), only 7/19 were detected by US (sensitivity 37%). US is insensitive for DVT in the central upper venous system but may be more sensitive than venography in the jugular veins. A combination of both venography and US is required for screening for DVT in the upper venous system.	3
33. Koksoy C, Kuzu A, Kutlay J, Erden I, Ozcan H, Ergin K. The diagnostic value of colour Doppler ultrasound in central venous catheter related thrombosis. *Clin Radiol*. 1995;50(10):687-689.	Observational-Dx	44 patients	Prospective study to establish the correlation between color Doppler US observations and venography in detecting CRT. Criteria used to show the presence of CRT included visualization of thrombus, absence of spontaneous flow, absence of phasicity of flow with respiration, incompressibility of the vein with probe pressure and visualization of increased venous collaterals.	Analyzing each variable separately, phasicity of flow with respiration had the highest sensitivity (94%) and spontaneous flow had the highest specificity (100%). The best combinations for diagnosis were visualization of thrombus + phasicity of flow with respiration, phasicity of flow with respiration + spontaneous flow, and visualization of thrombus + phasicity of flow with respiration + spontaneous flow with a sensitivity of 94% and specificity of 88%. Overall diagnostic value of color Doppler US had a sensitivity of 94% and specificity of 96%.	3
34. Weissleder R, Elizondo G, Stark DD. Sonographic diagnosis of subclavian and internal jugular vein thrombosis. *J Ultrasound Med*. 1987;6(10):577-587.	Review/Other-Dx	7 patients	Patients with internal jugular and/or subclavian vein thrombosis were studied with real-time US and venography. High-resolution real-time US was used to tabulate morphologic parameters and physiologic parameters.	No results stated in abstract.	4
35. Pacheco H, Yesenko SL, Gornik HL, Abizer S, Bartholomew JR. Venous Thoracic Outlet Syndrome Diagnosed Using Duplex Ultrasound. *Journal for Vascular Ultrasound*. 2009;33(4):184-187.	Review/Other-Dx	1 patient	To describe the case of a 52-year-old female patient with a history of bilateral upper-extremity swelling and pain and a past history of bilateral subclavian DVT.	The duplex examination revealed normal color flow and a respirophasic pulsed Doppler waveform in the subclavian veins bilaterally with the patient lying supine in the resting position. With abducting the arms, significant changes were noted. Occlusion of the subclavian vein was observed at its proximal segment with absent color flow and pulsed Doppler spectrum. Flow was reestablished after having the patient relax her arm to its resting position. These findings were documented in both the right and left subclavian veins. There was no evidence of residual DVT or venous reflux on either side.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
36. Chin EE, Zimmerman PT, Grant EG. Sonographic evaluation of upper extremity deep venous thrombosis. *J Ultrasound Med.* 2005;24(6):829-838; quiz 839-840.	Review/Other-Dx	N/A	To review the techniques of performing an upper extremity Doppler examination, in addition to illustrating the sonographic appearances of acute and chronic UEDVT.	Color Doppler US is accurate in the diagnosis of UEDVT. However, in cases of equivocal Doppler findings, or when the sonographic findings are normal but clinical suspicion for central venous thrombosis is high, MRI or contrast venography is necessary for further evaluation.	4
37. Haire WD, Lynch TG, Lund GB, Lieberman RP, Edney JA. Limitations of magnetic resonance imaging and ultrasound-directed (duplex) scanning in the diagnosis of subclavian vein thrombosis. *J Vasc Surg.* 1991;13(3):391-397.	Review/Other-Dx	43 arm phlebograms	Correlate the results of phlebograms with duplex and MRI scans of the thoracic veins to determine the potential role of MRI and duplex scanning in the diagnosis of catheter-induced subclavian vein thrombosis.	Duplex scans detected 6/11 occlusions, whereas MRI detected 4 of the 5 occlusions scanned. Of 14 nonocclusive thrombi seen on phlebography, duplex scans correctly identified 8. MRI was done on 8 nonocclusive thrombi but identified only 2. Short occlusions of the proximal portion of the left subclavian vein were often undetected by duplex scanning but occasionally seen with MRI. MRI is highly reliable in ruling out the presence of a thrombotic process in the subclavian vein, but it may on occasion fail to detect the presence of subclavian thrombi.	4
38. Svensson WE, Mortimer PS, Tohno E, Cosgrove DO. Colour Doppler demonstrates venous flow abnormalities in breast cancer patients with chronic arm swelling. *Eur J Cancer.* 1994;30A(5):657-660.	Review/Other-Dx	81 patients	Patients with chronic arm swelling related to their breast cancer treatment were examined with color Doppler imaging. Findings are reported.	Over half (57%) of the patients had evidence of venous outflow obstruction and a further 14% had signs of venous "congestion". Only 30% of the swollen arms had normal venous outflow. The venous systems of the contralateral nonswollen arms were all normal as were both arms in 28 control patients who had similar treatment but had not developed arm swelling. Findings suggest that venous outflow obstruction is an important contributory factor in the pathophysiology of arm swelling following breast cancer treatment.	4
39. Weber TM, Lockhart ME, Robbin ML. Upper extremity venous Doppler ultrasound. *Radiol Clin North Am.* 2007;45(3):513-524, viii-ix.	Review/Other-Dx	N/A	To review the role of US in the evaluation of upper extremity venous system.	US provides an accurate, rapid, low-cost, portable, noninvasive method for screening, mapping, and surveillance of the UEDVT system.	4
40. Grassi CJ, Polak JF. Axillary and subclavian venous thrombosis: follow-up evaluation with color Doppler flow US and venography. *Radiology.* 1990;175(3):651-654.	Review/Other-Dx	13 patients	Real-time US and color Doppler flow mapping were used to determine prospectively whether UEDVT could be imaged as accurately as with conventional contrast venography.	Color Doppler flow US is useful in evaluating UEDVT and might be preferable to venography for follow-up because the discomfort of injection and risk of contrast material-induced phlebitis are eliminated.	4

Upper Extremity Swelling
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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
41. Gaitini D, Beck-Razi N, Haim N, Brenner B. Prevalence of upper extremity deep venous thrombosis diagnosed by color Doppler duplex sonography in cancer patients with central venous catheters. *J Ultrasound Med.* 2006;25(10):1297-1303.	Review/Other-Dx	N/A	To review the literature concerning UEDVT diagnosed by color Doppler duplex US in cancer patients with indwelling CVCs.	Color Doppler duplex US is an accurate examination for the diagnosis of UEDVT, with sensitivity ranging from 78% to 100% and specificity ranging from 82% to 100%.	4
42. Haire WD, Lynch TG, Lieberman RP, Lund GB, Edney JA. Utility of duplex ultrasound in the diagnosis of asymptomatic catheter-induced subclavian vein thrombosis. *J Ultrasound Med.* 1991;10(9):493-496.	Review/Other-Dx	32 subclavian catheters	Prospective study to determine the usefulness of duplex US in the diagnosis of asymptomatic catheter-induced subclavian vein thrombosis.	16 arm venograms were normal and all gave normal duplex scans. 11 venograms demonstrated nonocclusive mural thrombi. Only 3 of these were seen with duplex US. 5 totally occlusive thrombi were seen on venography, of which only 2 were detected with duplex US. The insensitivity of this technique to asymptomatic subclavian thrombi limits its usefulness as a screening tool.	4
43. Ho VB, Corse WR, Hood MN, Rowedder AM. Magnetic resonance angiography of the thoracic vessels. *Magnetic Resonance Imaging Clinics of North America.* 2004;12(4):727-747.	Review/Other-Dx	N/A	A review on MRA of the thoracic vessels.	No results stated in abstract.	4
44. Hansen ME, Spritzer CE, Sostman HD. Assessing the patency of mediastinal and thoracic inlet veins: value of MR imaging. *AJR Am J Roentgenol.* 1990;155(6):1177-1182.	Observational-Dx	31 patients	Review hospital records and MR studies to assess the accuracy of MRI in the evaluation of patients with suspected thoracic venous obstruction.	MRI correctly identified abnormality in 32/34 vessels (sensitivity 94%). In all cases, a negative MR study was found to be a true negative (no false positives in 42 normal vessels; specificity, 100%).	3

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
45. Blume U, Orbell J, Waltham M, Smith A, Razavi R, Schaeffter T. 3D T(1)-mapping for the characterization of deep vein thrombosis. *MAGMA.* 2009;22(6):375-383.	Review/Other-Dx	phantom and 8 healthy volunteers; 5 patients with DVT	To investigate fast T1-mapping for the characterization of DVT. Accuracy and reproducibility of the T1-mapping sequence was tested in phantoms and in healthy volunteers on a 1.5T clinical scanner using a 32-channel array coil.	Results of phantom and volunteer study showed a high accuracy and reproducibility for the quantification of T1. The resolution of the T1-maps was high enough to identify small anatomical structures. T1 values derived for normal blood and various other tissues were comparable to those reported in the literature. In all patients, the T1 times of thrombi showed decreased values (T1 = 843 +/- 91 ms) in the acute phase and recovered back to normal values of blood (T1 = 1,317 +/- 36 ms) after 6 months. Measurement of all relevant T1 values of acute thrombi and normal blood achieved accurate and reproducible results in vivo. Fast T1 quantification of the thrombus can provide information about tissue characteristics such as thrombus resolution. Such a quantitative MRI technique may be valuable in studying the factors that influence natural resolution and in evaluating treatment effects that enhance this process.	4
46. Baarslag HJ, Van Beek EJ, Reekers JA. Magnetic resonance venography in consecutive patients with suspected deep vein thrombosis of the upper extremity: initial experience. *Acta Radiol.* 2004;45(1):38-43.	Observational-Dx	44 patients	To assess the feasibility and accuracy of 2 MRV methods in a consecutive series of patients with suspected UEDVT.	The sensitivity and specificity of time of flight MRV vs gadolinium 3D-MRV was 71% and 89% vs 50% and 80%, respectively. A high number of patients were unable to undergo MRV in this setting. Contrast-enhanced MRV did not improve diagnostic accuracy. The clinical utility of MRV in the setting of suspected UEDVT seems disappointing.	2
47. Finn JP, Zisk JH, Edelman RR, et al. Central venous occlusion: MR angiography. *Radiology.* 1993;187(1):245-251.	Review/Other-Dx	30 patients	To evaluate usefulness of time-of-flight MRA in patients with suspected thoracic venous occlusion by comparing MR studies with contrast venography results.	Correlation was excellent between findings of venous obstruction and occlusion at contrast venography and MRA. MRI provided more comprehensive information than catheter venography on central venous anatomy and blood flow. For evaluation of central veins, MRA is an accurate and graphic technique that may succeed in cases in which other methods may give inadequate findings or may be impossible to perform.	4

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
48. Vogt FM, Herborn CU, Goyen M. MR venography. *Magn Reson Imaging Clin N Am.* 2005;13(1):113-129, vi.	Review/Other-Dx	N/A	To review existing MR techniques used for the assessment of the venous system and summarize the clinical experience. New applications that are likely to increase the use of MRV in clinical practice are also reviewed.	MRV has successfully shown its potential to evaluate DVT, central venous pathology, and anatomic variants such as venous malformations with high accuracy and has become a supplementary imaging technique to conventional venography, duplex US, and CT. Technical limitations, high cost, limited availability, and logical constraints still prevent widespread clinical use, however.	4
49. Spritzer CE. Progress in MR imaging of the venous system. *Perspect Vasc Surg Endovasc Ther.* 2009;21(2):105-116.	Review/Other-Dx	N/A	To review the utility of MRI/MRV in the assessment of common venous problems.	No results stated in abstract.	4
50. Cantwell CP, Cradock A, Bruzzi J, Fitzpatrick P, Eustace S, Murray JG. MR venography with true fast imaging with steady-state precession for suspected lower-limb deep vein thrombosis. *J Vasc Interv Radiol.* 2006;17(11 Pt 1):1763-1769.	Experimental-Dx	24 patients	Prospective study of randomly selected patients to compare true FISP MRV for suspected DVT with contrast agent-enhanced venography.	When results were analyzed on a per-patient basis, there was good agreement between contrast venography and MRV (kappa=0.64; 95% CI, 0.33–0.94; *P*=.0001). When the venous system was analyzed on a segmental basis, there was very good agreement between contrast venography and MRV (kappa=0.81; 95% CI, 0.68–0.94; *P*=.0001). The sensitivity and specificity for DVT detection were 100% for the iliac and popliteal segments and 100% and 98%, 68% and 94%, and 87% and 98%, respectively, for the femoral, below-knee, and all veins. MRV with axial true FISP allows noninvasive rapid diagnosis of acute DVT in the iliac, femoral, popliteal, and calf muscle veins. MRV is much less reliable in the tibial or peroneal veins. It may demonstrate a nonvenous cause of a patient's symptoms.	1
51. Miyazaki M, Sugiura S, Tateishi F, Wada H, Kassai Y, Abe H. Non-contrast-enhanced MR angiography using 3D ECG-synchronized half-Fourier fast spin echo. *J Magn Reson Imaging.* 2000;12(5):776-783.	Review/Other-Dx	16 healthy volunteers	To examine the thoracic and iliac regions in volunteers at both 0.5 and 1.5 T using a ECG synchronized 3D half-Fourier fast spin-echo technique with an appropriate ECG delay time for every slice encoding in 3D terms.	Good-quality 3D MRA images were obtained in the thoracic and abdominal regions and the weighted subtraction of 2 images in different phases provides contrast enhancement between arteries and veins. Fast spin-echo may be a useful technique to evaluate peripheral arteries without the use of gadolinium.	4

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EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
52. Pedrosa I, Morrin M, Oleaga L, Baptista J, Rofsky NM. Is true FISP imaging reliable in the evaluation of venous thrombosis? *AJR Am J Roentgenol.* 2005;185(6):1632-1640.	Observational-Dx	25 MR exams in 24 patients; 2 independent reviewers	Retrospective study to evaluate the accuracy of true FISP in the diagnosis of venous thrombosis using gadolinium-enhanced 3D T1-weighted gradient-echo images and correlative imaging as the gold standard.	Venous thrombosis was present in 25 veins in 18 patients. True FISP images had a lower sensitivity (66%) and specificity (70.9%) for the diagnosis of venous thrombosis than gadolinium-enhanced MR images ($P<0.01$). True FISP images have lower sensitivity and specificity in the diagnosis of venous thrombosis than gadolinium-enhanced T1-weighted gradient-echo images. True FISP images should not be used exclusively for the diagnosis of venous thrombosis.	3
53. Denson K, Morgan D, Cunningham R, et al. Incidence of venous thromboembolism in patients with traumatic brain injury. *Am J Surg.* 2007;193(3):380-383; discussion 383-384.	Review/Other-Dx	5,787 patients	To review the incidence of venous thromboembolism in critically injured patients with an isolated traumatic brain injury using a standardized venous duplex color-flow Doppler imaging program and to compare it with the overall and high-risk trauma populations.	539 (9%) of 5,787 were deemed high-risk for venous thromboembolism. The incidence of venous thromboembolism in patients with isolated traumatic brain injury (88, 16%) was 25%. All patients and the high-risk population had incidences of 2% and 17%, respectively. The incidence of venous thromboembolism in isolated traumatic brain injury is greatest in patients with intraparenchymal hemorrhage. Early venous thromboembolism prophylaxis is warranted in traumatic brain injury patients.	4
54. Tanju S, Sancak T, Dusunceli E, Yagmurlu B, Erden I, Sanlidilek U. Direct contrast-enhanced 3D MR venography evaluation of upper extremity deep venous system. *Diagn Interv Radiol.* 2006;12(2):74-79.	Observational-Dx	19 patients	To compare MRV and conventional angiograms to determine the diagnostic value of direct contrast-enhanced 3D MRV in mapping the UEDVT and to plan potential interventional procedures.	Results of MRV and conventional angiography were consistent with each other (100% sensitivity and 100% specificity). Direct contrast-enhanced 3D MRV is a well-tolerated sensitive technique in explaining the cause of the malfunctioning arterio-venous fistulas and in pre-surgical planning before placing new catheters or creating fistulas.	2

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
55. Vymazal J, Spuentrup E, Cardenas-Molina G, et al. Thrombus imaging with fibrin-specific gadolinium-based MR contrast agent EP-2104R: results of a phase II clinical study of feasibility. *Invest Radiol*. 2009;44(11):697-704.	Experimental-Dx	52 total patients: patients with confirmed thrombus in the venous system (n = 14), or heart, or arterial system (n = 38)	To determine the feasibility of detecting thrombi using a fibrin-specific gadolinium-based magnetic resonance imaging contrast agent, EP-2104R.	Overall, 29 thrombi were visible before contrast administration, 3/14 in the venous system, and 26/38 in the arteries and heart. Thrombi generally enhanced in signal after EP-2104R injection, and an additional 7 were visualized. After contrast, 4/14 thrombi were visible in the venous system, and 32/38 in the arteries and heart. Thrombi were more conspicuous when imaged at 2 to 6 hours post EP-2104R compared with within 1 hour, because of lower blood background. Quantitatively, the post: pre signal intensity ratio was 1.90 at 2 to 6 hours post injection (standard deviation = 1.08, N = 20, $P<0.001$); and 2.04 (standard deviation = 1.29, N = 19, $P<0.0025$) for the 20 to 36 hours time point. There were no serious adverse events considered related to study drug.	3
56. Kim CY, Mirza RA, Bryant JA, et al. Central veins of the chest: evaluation with time-resolved MR angiography. *Radiology*. 2008;247(2):558-566.	Observational-Dx	27 consecutive patients; 6 reviewers	To retrospectively assess the diagnostic performance of time-resolved MRA in the detection of stenoses and occlusions in the central veins of the chest, with angiographic and surgical findings and consensus readings serving as the reference standard.	The addition of time-resolved angiographic images to the high-spatial-resolution images resulted in improved specificity in the detection of venous occlusions (0.99 vs 0.96, $P=.03$), in reader confidence ($P<.001$), and in the ability to infer the side of injection (83% correct compared with 32% correct, $P<.001$), without increasing the average time required for study interpretation. Use of time-resolved angiographic data sets as a stand-alone technique had high sensitivity (0.95) but only moderate specificity (0.56) in the detection of venous stenoses or occlusions.	2

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
57. Nael K, Moriarty JM, Finn JP. Low dose CE-MRA. *Eur J Radiol.* 2011;80(1):2-8.	Review/Other-Dx	N/A	To review existing state-of-the-art 3D contrast-enhanced-MRA strategies to reduce contrast dose and summarize current applications and clinical experience to date. The article also highlights evolving techniques, which the authors feel are likely to enhance the future impact of contrast-enhanced-MRA.	Low-dose and reduced-dose protocols for contrast-enhanced-MRA are practical and reproducible in the carotids, chest, abdomen and lower extremities. The higher the baseline signal-to-noise ratio, the more the potential for contrast dose reduction, so that 3.0T field strength, multi-channel RF architecture and high relaxivity contrast agents may support aggressive dose reduction strategies. Attention to detail in contrast infusion and image acquisition protocols is mandatory for reproducibility and quality control. Finally time resolved-MRA with ultra-low-dose contrast is likely to play an important role in patients at elevated risk of NSF.	4
58. Ruehm SG, Kroeger K, Bosk S, Massing S, Mteiescu S, Debatin JF. Thromboembolic disease: Assessment with whole body MR venography. *Academic Radiology*. 2005;12(5):S63.	Observational-Dx	30 patients	To assess the diagnostic accuracy of a comprehensive MR protocol comprising MRA of the pulmonary arteries and whole body MRV for the detection of thromboembolic disease.	For the detection of venous thrombosis, MRV showed an overall sensitivity and specificity of 95% and 93%, respectively.	3
59. Nael K, Krishnam M, Ruehm SG, Michaely HJ, Laub G, Finn JP. Time-resolved MR angiography in the evaluation of central thoracic venous occlusive disease. *AJR Am J Roentgenol.* 2009;192(6):1731-1738.	Observational-Dx	20 consecutive patients; 2 independent reviewers	Retrospective study to assess the feasibility and diagnostic performance of time-resolved MRA in the evaluation of central thoracic venous occlusive disease and to compare time-resolved MRA with conventional MRA and catheter angiography. Observers were blinded to demographic information and other correlative imaging findings.	Time-resolved MRA resulted in diagnostic-quality images that did not differ significantly in quality compared with conventional MRA. 31 segmental venous stenoses were identified. The kappa coefficient revealed moderate intermodality agreement (kappa = 0.54; 95% CI, 0.32-0.76) between time-resolved MRA and conventional MRA. When compared with catheter angiography, the sensitivity and specificity for the diagnosis of significant stenosis (≥70%) were 87.5% and 68% for time-resolved MRA and 90% and 90% for conventional MRA, respectively. Time-resolved MRA has the potential to be used as an initial and screening diagnostic tool obviating conventional MRA and its associated higher contrast dose in normal and near-normal examinations. However, because of its relatively lower specificity, adjunct use of conventional MRA is still required for accurate grading of venous occlusive disease.	2

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
60. Pinto C, Hickey R, Carroll TJ, et al. Time-resolved MR angiography with generalized autocalibrating partially parallel acquisition and time-resolved echo-sharing angiographic technique for hemodialysis arteriovenous fistulas and grafts. *J Vasc Interv Radiol.* 2006;17(6):1003-1009.	Observational-Dx	11 patients	To evaluate the imaging of hemodialysis arteriovenous fistulas and grafts with use of MRA with generalized autocalibrating partially parallel acquisition and time-resolved echo-sharing angiographic technique and compare the findings with those of digital subtraction angiography.	A total of 80 segments were evaluated by each observer. For both observers, sensitivity rates for the detection of stenosis, occlusion, and any disease were 100% (95% CI, 52%–100%), 100% (95% CI, 20%–100%), and 100% (95% CI, 60%–100%), respectively. For observer 1, specificity rates for the detection of stenosis, occlusion, and any disease were 96% (95% CI, 88%–99%), 100% (95% CI, 94%–100%), and 96% (95% CI, 88%–99%), respectively. For observer 2, the specificity rates for the detection of stenosis, occlusion, and any disease were 93% (95% CI, 84%–98%), 100% (95% CI, 94%–100%), and 93% (95% CI, 84%–97%), respectively. Linear-weighted kappa values for MRA and digital subtraction angiography were 0.78+/-0.084 and 0.62+/-0.152, respectively.	2
61. Sampson FC, Goodacre SW, Thomas SM, van Beek EJ. The accuracy of MRI in diagnosis of suspected deep vein thrombosis: systematic review and meta-analysis. *Eur Radiol.* 2007;17(1):175-181.	Review/Other-Dx	14 articles	Systematic review of literature and meta-analysis to estimate the diagnostic accuracy of MRI for DVT.	Pooled estimate of sensitivity was 91.5% (95% CI, 87.5%–94.5%) and the pooled estimate of specificity was 94.8% (95% CI, 92.6%–96.5%). Sensitivity for proximal DVT was higher than sensitivity for distal DVT (93.9% vs 62.1%). Individual studies reported sensitivity ranging from zero to 100%, while specificity ranged from 43% to 100%. MRI has equivalent sensitivity and specificity to US for diagnosis of DVT, but has been evaluated in many fewer studies, using a variety of different techniques.	4
62. Panzironi G, Rainaldi R, Ricci F, Casale A, De Vargas Macciucca M. Gray-scale and color Doppler findings in bilateral internal jugular vein thrombosis caused by anaplastic carcinoma of the thyroid. *J Clin Ultrasound.* 2003;31(2):111-115.	Review/Other-Dx	1 patient	To report the sonographic findings in a case of bilateral internal jugular vein thrombosis with mild symptoms.	There was evidence of direct infiltration of anaplastic thyroid carcinoma into the left internal jugular vein. Sonographic and CT examinations also demonstrated multiple dilated collateral veins.	4
63. Stam J. Thrombosis of the cerebral veins and sinuses. *N Engl J Med.* 2005;352(17):1791-1798.	Review/Other-Dx	N/A	To review pathogenesis of sinus thrombosis, risk factors, clinical and radiologic diagnosis and current evidence and controversies about the best treatment.	Sinus thrombosis remains a diagnostic challenge and a potentially disabling or lethal disease, but improved diagnosis and treatment now result in an excellent outcome for most patients.	4

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
64. Kim HC, Chung JW, Yoon CJ, et al. Collateral pathways in thoracic central venous obstruction: three-dimensional display using direct spiral computed tomography venography. *J Comput Assist Tomogr*. 2004;28(1):24-33.	Review/Other-Dx	N/A	To illustrate the spectrum of venous collateral pathways caused by the thoracic central venous obstruction with direct spiral CT venography and 3D reconstruction images.	Venous structures that can be demonstrated with CT venography include the jugular veins; the subclavian and brachiocephalic (innominate) veins; the internal and lateral thoracic veins; the superior and inferior venae cavae; the pericardiophrenic veins; the azygos, hemiazygos, and accessory hemiazygos veins; and the intercostal veins.	4
65. Sabharwal R, Boshell D, Vladica P. Multidetector spiral CT venography in the diagnosis of upper extremity deep venous thrombosis. *Australas Radiol.* 2007;51 Suppl:B253-256.	Review/Other-Dx	1 patient	To present a case which demonstrates the limitations in diagnostic accuracy of US in the diagnosis of UEDVT.	Multidetector spiral CT continues to evolve as a state of the art imaging modality and this case demonstrates the role and value of multidetector spiral CT venography in the diagnosis of UEDVT.	4
66. Kim H, Chung JW, Park JH, et al. Role of CT venography in the diagnosis and treatment of benign thoracic central venous obstruction. *Korean J Radiol.* 2003;4(3):146-152.	Observational-Dx	18 patients; 2 observers	CT venography and digital subtraction venography were compared to evaluate the role of CT venography in the diagnosis and treatment of benign thoracic central venous obstruction.	In all patients, CT venography depicted the causes of obstruction, including extrinsic compression of the left brachiocephalic vein, and mediastinal inflammatory pseudotumor. Interobserver agreement regarding classification of the degree of obstruction was judged as good for CT venography (K=0.864), and in evaluating this, there was significant correlation between CT venography and digital subtraction venography (reader 1: Rs = 0.58, $P<0.01$; reader 2: Rs = 0.56, $P<0.01$). In evaluating the status of central veins proximal to long segmental obstruction, and associated thrombosis, CT venography was superior to digital subtraction venography. In half of all patients, the findings of CT venography led to changes in the treatment plan.	1

Upper Extremity Swelling
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
67. Arrive L, Crema MD, Lewin M, et al. Computed tomography features of acute thrombosis of central veins with perivenous inflammatory changes. *J Comput Assist Tomogr*. 2007;31(6):931-935.	Review/Other-Dx	13 patients with acute DVT of 21 central veins	To examine the CT findings in patients with acute DVT of central veins of the neck, chest, and abdomen in whom major perivenous inflammatory changes were noted.	The perivenous changes took the form of a rounded or lobulated perivenous bulky mass (massive pattern or tumor like) in 5 patients and of infiltrative changes in the other 8 patients. Direct visualization of the thrombotic vein was possible in 8 patients. Follow-up examinations (range, 6-36 months; mean, 15 months) demonstrated resolution of perivenous inflammatory changes with anticoagulation therapy in all cases. Perivenous inflammatory changes around the thrombotic vein presented as a rounded or lobulated perivenous bulky mass that may mimic a tumor or as infiltrative perivenous changes.	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  c) the study is an expert opinion or consensus document.

Dx = Diagnostic

Tx = Treatment

Abbreviations Key

CI = Confidence interval

CRT = Catheter-related thrombosis

CT = Computed tomography

CVC = Central venous catheter

ECG = Electrocardiogram

FDG-PET = Fluorine-18-2-fluoro-2-deoxy-D-glucose-positron emission tomography

FISP = Fast imaging with steady-state precession

DVT = Deep venous thrombosis

MRA = Magnetic resonance angiography

MRI = Magnetic resonance imaging

MRV = Magnetic resonance venography

NPV = Negative predictive value

OR = Odds ratio

PE = Pulmonary embolism

PICC = Peripherally inserted central catheters

PPV = Positive predictive value

SUV = Standardized uptake value

UEDVT = Upper extremity deep vein thrombosis

US = Ultrasound