Incidence of Catheter-Associated Right Atrial Thrombus Detected by Transthoracic Echocardiogram

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Abstract

Introduction: The development of right atrial (RA) thrombus (RAT) is a known complication of central venous catheter insertion (CVC). Deeper insertion of CVC within the RA may increase the risk for RAT development versus those placed at the superior vena cava (SVC)-RA junction. We sought to evaluate the incidence of catheter-associated RAT as detected by transthoracic echocardiograms (TTEs), characterize thrombi though multimodal imaging, and evaluate thrombi management with follow-up imaging. Methods: A retrospective analysis was conducted of consecutive TTEs from our institution between October 1, 2018, and January 1, 2020 in which a venous catheter was visualized in the RA. Studies were reviewed in detail to determine presence of suspected RAT. Demographic data, comorbidities, laboratory values, characteristics of the catheter and the thrombus, subsequent imaging and management, and outcomes were collected. Results: A total of 364 TTEs were performed in 290 patients with a venous catheter visualized in the RA. Of these 290 patients, 15 had an imaging suspicion for RAT yielding an incidence of 5.2%. Management strategies included anticoagulation in 13 (86.7%) patients and catheter removal in 11 (73.3%) patients. At eight months follow-up, 11 (73.3%) patients had resolution of RAT based on subsequent imaging. Conclusion: In patients with deeply placed CVC catheters, the incidental detection of RAT by TTE was not trivial. Anticoagulation and catheter removal and replacement, if deemed safe, were effective methods of thrombus management. RAT as a complication of CVCs must be accounted for when addressing factors that influence depth of CVC insertion.

Introduction

Central venous catheters (CVCs) are commonly utilized for a variety of clinical purposes, including hemodialysis access, infusion of medications such as chemotherapy, and total parenteral nutrition. The reliable provision of vascular access with a CVC offers many advantages in the management of chronic disease, and CVCs routinely remain in place long-term. However, their presence also introduces the risk of development of known complications such as infection, thrombotic obstruction of the catheter lumen, and external thrombus development in association with the catheter.[1,2]

CVCs are commonly placed such that the tip rests in the superior vena cava (SVC), at the cavoatrial junction, or within the right atrium (RA) itself. The development of right atrial thrombus (RAT) in association with a CVC is a known complication which exhibits a strong association with protrusion of the catheter tip into the right atrium.[3] RA thrombi have been implicated in septic emboli, arrhythmia, and embolization to the pulmonary vasculature, increasing the risk of morbidity and mortality.[2,4-8]

Although previous case reports and case series present instances of RAT, evaluations of its incidence in the presence of CVCs have typically been reported in small sample sizes and vary from 5.4% in hemodialysis patients to nearly 30% based on autopsies of patients who died with a CVC present.[9,10] The primary purpose of this study was to evaluate the incidence of development of catheter-associated RAT as detected incidentally by transthoracic echocardiograms (TTEs) in patients with a CVC tip in the RA. Secondarily, we characterize

imaging features of observed thrombi and the clinical features of the patients with RAT, describe the utility of multiple modalities of follow-up imaging for thrombus evaluation, and discuss thrombus management and resolution in our study population.

Methods

A single center retrospective study was performed. This study was approved by our institutional review board (STU00212587). Echocardiography reporting software Syngo (Siemens Healthineers, Erlangen, Germany) was utilized to identify all TTEs between October 1, 2018 and January 1, 2020 in which a venous catheter was visualized in the right atrium of the heart. Structured data fields are routinely utilized by our sonographers and echocardiographers. Each study was then reviewed in detail to determine presence of suspected RAT. The electronic medical record was reviewed to obtain demographic data and past medical history including malignancy, cardiovascular disease history, previous deep vein thromboses and thromboembolic events, and kidney disease. Laboratory values for platelets and international normalized ratio (INR) were collected when available on or shortly before the day of thrombus discovery. Details regarding the indication for the catheter as well as type, date of insertion, and location on imaging were acquired. Characteristics of the thrombus including size and attachment to the atrial wall or catheter were collected. Furthermore, subsequent imaging and management including thrombectomy, initiation of anticoagulation, and adjustment, removal, and replacement of the catheter were reviewed. Outcome was examined by determining whether the thrombus resolved on follow-up imaging and by recording any embolic events attributed to the right atrial thrombus.

Results

A total of 364 TTEs were performed in 290 patients with a venous catheter visualized in the RA during the study period. Of these 290 patients, 15 (5.2%) had echocardiographic suspicion for RAT. The mean patient age was 41.7 ± 12.3 years, and 12 (80.0%) were female. Eight (53.3%) patients had hypertension, six (40.0%) had end-stage renal disease, four (26.7%) had previous DVT or thrombotic event, four (26.7%) had a history of acute kidney injury, four (26.7%) patients had malignancy, and three (20.0%) had hypercholesterolemia.

Characteristics of each case are presented in Table I. Nine (60.0%) of the catheters were indicated for hemodialysis, four (26.7%) for chemotherapy, and two (13.3%) for plasmapheresis. Each TTE was performed for clinical indications rather than as routine surveillance. Thrombi were detected by TTE in each case with a median interval of 52 days between catheter insertion and thrombus discovery. Eight (53.3%) thrombi were attached to the RA free wall, four (26.7%) to the catheter, and three (20.0%) to both. Further imaging was obtained in ten (66.7%) patients, consisting of TEE in all (100%) and cardiac magnetic resonance (CMR) imaging in three (20.0%) patients.

A number of strategies were employed in the management of the thrombi. Anticoagulation was utilized in 13 (86.7%) patients for a mean of 7.9 months. The catheter was removed in eleven (73.3%) patients, and replaced in four (26.7%) of these patients. The catheter was trimmed to a shorter length in two (13.3%) patients. Resolution of the thrombus was confirmed in eleven (73.3%) patients at a mean of 96.1 days after discovery. One patient experienced a subsegmental pulmonary embolism attributed to a RAT.

Discussion

Incidence and Factors Associated with Thrombus Development

We report that in 290 patients with a CVC tip seated in the RA, incidental detection of RAT by clinically indicated TTE was 5.2%. To the best of our knowledge, this study is the largest series in which an incidence of catheter-associated RAT has been reported in patients with a catheter tip seated in the RA. Previous estimates of incidence range from 8.8-24% in cancer patients, 5.4% in hemodialysis patients, and nearly 30% as detected by autopsy in patients who died with a CVC present.[3,9-12] However, these estimates were not specific for patients in whom the catheter tip is specifically present in the RA. Plodkowski et al noted that catheter-associated RAT is associated with the extent to which the catheter protrudes into the RA.[12] Similarly, Gilon et al found a strong association between RAT and catheter tip placement in the RA as

opposed to the cavoatrial junction or SVC.[3] However, other studies have reported that catheter tip placement in the cavoatrial junction may not prevent RAT in comparison to placement in the RA.[11,13] CVC catheters placed distally in the RA may encounter more "swirling" or turbulent blood flow and predispose to thrombus formation compared to catheters in the SVC in which the venous vessel wall may facilitate more laminar blood flow.

Our study confirms that the placement of a catheter tip in the RA entails a risk for RAT, raising concerns regarding institutional practices that may feature variations in recommended CVC insertion depth. Myriad complex factors may guide these practices such as balancing the potential for complications with achievement of the best possible infusion flow.[14] Our study shows that the possibility of RAT when CVC protrudes beyond cavoatrial junction should be considered. Furthermore, our study demonstrates the ability of clinically indicated TTE to incidentally detect RAT.

Management

Reports of catheter-associated RAT management vary widely. Outcomes following anticoagulation are generally favorable and reports have shown benefits of dual antiplatelet therapy following catheter removal.[10,13,15] In a meta-analysis, Stavroulopoulos et al demonstrated that maintenance of the catheter in place after thrombus discovery was significantly and independently associated with mortality, favoring management strategies that include catheter removal and anticoagulation.[7,16] Our series showed a high rate of thrombus resolution with routine anticoagulation and catheter removal when deemed clinically appropriate, with replacement as necessary. Awareness of the potential for RAT and appropriate surveillance is critical in order to properly address RAT that develop.

Role of Transthoracic Echocardiography

Placement of CVC catheters with the intent of providing intermediate or longer-term venous access (chemotherapy, hemodialysis) often takes place under fluoroscopic guidance. Careful placement of the CVC catheter, ideally at the cavoatrial junction may be preferred given the high incidence of RAT noted in this study. In cases of SVC narrowing or problems with flow that require more distal placement of the CVC catheter, consideration should be given to periodic surveillance of for thrombotic complications, especially in higher-risk patients. In one third of patients in this analysis, RAT was noted within 30 days of placement of the CVC, underscoring the fairly quick development of thrombus. In each of these five cases, the catheter was removed or replaced and four of these five cases, anticoagulation was also prescribed resulting in thrombus resolution. TTE with adequate sweeps to interrogate the body of the RA in addition to the CVC tip may enhance the detection of intracardiac thrombus. When RAT is suspected based on TTE imaging, subsequent imaging for TEE or CMR can be helpful to further characterize the morphology, size, and attachment points of the mass.

Limitations

This study has several limitations. The study was subject to bias because of its retrospective nature. TTE has previously been reported to have a 75% sensitivity and 90% specificity for RAT detection, indicating that our reported incidence of 5.2% is likely to be lower than the true incidence of RAT development in patients with a CVC in the RA.[12] Furthermore, detection of RAT was limited to patients receiving clinically indicated imaging. A study surveilling each patient with CVC tip in the RA would provide the most accurate estimate of catheter-associated RAT.

Conclusions

In patients with deeply placed CVC catheters, the incidental detection of RAT by TTE was not trivial. Anticoagulation and catheter removal and replacement, if deemed safe, were effective methods of thrombus management. RAT as a complication of CVCs must be taken into account when addressing factors that influence depth of CVC insertion. Surveillance TTE in patients with deeply placed CVC catheters is reasonable.

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Table 1: Summary of individual cases where right atrial (RA) thrombus was detected on transthoracic echocardiogram (TTE). Transesophageal echocardiogram (TEE), anticoagulation (AC), cardiac magnetic resonance imaging (CMR).

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Patient Number	Age (years)	Sex	Catheter indication	Reason for TTE
1	39	F	Hemodialysis	Pericardial effusion

Patient Number	Age (years)	Sex	Catheter indication	Reason for TTE
2	51	F	Chemotherapy (acute myeloid leukemia)	Murmur
3	47	M	Hemodialysis	Renal failure
4	26	F	Plasmapheresis	Pulmonary embolism
5	43	F	Plasmapheresis	Pulmonary hypertension
6	37	M	Chemotherapy (seminoma)	Heart failure
7	62	F	Hemodialysis	Shock
8	34	F	Hemodialysis	Heart failure
9	28	M	Hemodialysis	Endocarditis
10	31	F	Hemodialysis	Aortic and mitral valve rep
11	61	F	Chemotherapy (breast, invasive ductal carcinoma)	Dyspnea
12	24	F	Chemotherapy (sigmoid colon adenocarcinoma)	Murmur
13	57	F	Hemodialysis	Heart failure
14	36	F	Hemodialysis	Syncope
15	44	F	Hemodialysis	Bacteremia

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