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Original Research

## Surgical Management of Peripheral Vein Thrombophlebitis in the Upper Extremity



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**Purpose:** Peripheral vein thrombophlebitis has a reported overall incidence ranging from 20% to 80%. Thrombophlebitis can progress despite antibiotic therapy to become a challenging clinical problem requiring surgical intervention. There is currently no consensus on its optimal management. We reviewed our experience of surgical intervention with analyses of the indications for intervention, descriptions of the surgical procedures, and outcomes. We aimed to provide guidance on the management of this potentially serious complication.

**Methods:** This is a retrospective review of 51 patients with thrombophlebitis refractory to conservative management between January 2017 and August 2020.

**Results:** Analyses revealed a high prevalence of comorbidities, including diabetes mellitus, malignancy, and chronic kidney disease. A total of 60% of patients had concurrent bacteremia, and the decision to operate had a low threshold in the presence of these factors. On exploration, 80% of patients had intraluminal thrombus, 47% had intraluminal pus, and 29% had pus beyond the veins or extending proximally. The surgical approach employed in 98% of patients involved an extensile incision in those with several morbidity factors (diabetes mellitus, chronic kidney disease, or bacteremia). One patient presented with severe clinical signs of local infection, and on exploration, there was intraluminal pus and thrombus up to 10 cm. A novel technique of a minimally invasive approach of intermittent stab incisions was employed in a young and healthy patient without comorbidities.

**Conclusions:** We developed an algorithm to guide the indications for intervention and surgical approach to thrombophlebitis. The threshold for intervening surgically should be lowered by the presence of comorbidities. The failure of antibiotics to resolve the clinical signs of infection or the suspicion of abscess formation should mandate intervention. Thrombosed sections of the vein should be ligated proximally and distally and excised and surrounding collections of pus drained. Delayed secondary wound closure is usual. Stab incisions may limit surgical dissection and subsequent scarring in less severe cases.

**Type of study/level of evidence:** Prognostic IV.

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Intravenous cannulation may give rise to an iatrogenic infection of suppurative thrombophlebitis. However, in established cases, it is often impossible to know whether the infection has arisen from

procedures at the time of catheter insertion, during subsequent wound management, or from systemic bacteremia. This is commonly perceived as a benign problem that is managed conservatively according to a Cochrane review in 2015, which mainly focused on assessing the effectiveness of different treatment modalities for conservative management.<sup>1</sup> It reported that there is currently no consensus on the optimal management of peripheral vein thrombophlebitis in the upper extremity. Thrombophlebitis can progress despite antibiotic therapy to become a challenging clinical problem requiring surgical intervention.<sup>2,3</sup> Intravenous catheters have patient sepsis rates of 3.6%, according

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**Table 1**  
Characteristics of Surgically Managed Patients With Thrombophlebitis, N = 51

Variable	Mean ± SD/Frequency (%)
Age (y)	65 ± 13
Male	58.8
Site of thrombophlebitis	
Forearm	25
Dorsum/Hand	28
Wrist	26
Antecubital fossa	21
Clinical manifestation	
Pain	80
Swelling	92
Erythema	84
Induration	64
Palpable venous cord	28
Pyrexia	24
Fluctuance	22
Pus	12
Ascending lymphangitis	6
Comorbidities	
Diabetes mellitus	59
Hyperlipidemia	51
Hypertension	57
Chronic kidney disease (stage 3 and above)	29
Malignancy	35
Chemotherapy	14
Steroid use	6
Drug abuse history	4
Autoimmune conditions	12
Previous thrombophlebitis	4
Intercurrent illness	53
Bacteremia	60
Imaging	24

to a study by the Centers for Disease Control.<sup>4</sup> There is a risk of potentially life-threatening complications of metastatic infection, septic pulmonary emboli, and acute endocarditis, which can lead to increased morbidity and mortality.<sup>2,5</sup>

Thus, peripheral vein thrombophlebitis remains an ongoing challenge with no consensus on the role of surgical management.<sup>1,6,7</sup> This study was designed to provide guidance on the management of this potentially serious complication. First, the indications for surgical intervention for peripheral vein thrombophlebitis were examined. Second, surgical management techniques and outcomes of peripheral vein thrombophlebitis were assessed. This study evaluated whether there was a high prevalence of patients with comorbidities, including diabetes mellitus, malignancy, or chronic kidney disease, requiring surgical intervention when they developed peripheral vein thrombophlebitis in the upper extremity.

## Materials and Methods

This is a retrospective observational study of patients who underwent surgical management of peripheral vein thrombophlebitis of the upper extremity at a single tertiary institution between January 2017 and August 2020. These patients were identified because they were referred to the Hand Surgery team for consideration of thrombophlebitis by other medical teams. These patients were assessed by other medical teams to likely require surgical intervention. This included patients with thrombophlebitis that was refractory or assessed to be difficult to resolve with conservative management and appropriate antibiotic therapy. Once these patients were referred, they were evaluated by the Hand Surgery team to determine if surgical intervention was required. Thrombophlebitis was identified clinically and defined as the presence of 2 or more of the following signs or symptoms on the examination of

the catheter insertion site: pain, tenderness, erythema, swelling, purulence, and a palpable venous cord.<sup>8–10</sup> This is in accordance with the widely used Visual Infusion Phlebitis scale in the diagnosis of thrombophlebitis.<sup>11</sup> The study population consisted of 51 patients. At that time, 109 patients were treated without surgery. This study conformed to the Strengthening the Reporting and Observational Studies in Epidemiology guidelines. The study was approved by the ethics committee and centralized institutional review board (reference number 2019/2157).

The data on the demographic and clinical characteristics, surgical management, bacteriology, histology, and antibiotic therapy were obtained from electronic medical records.

Data analyses were performed using IBM SPSS version 21 (SPSS Inc). Baseline demographic characteristics and clinical features were reported as means and SDs for continuous variables and frequency (percentage) for categorical variables.

## Results

Table 1 presents the characteristics of surgically managed patients with thrombophlebitis. The patients had an average age of 65 years, and 30 were men. There was a predominance of patients with intercurrent illness (n = 27) and chronic comorbidities, including diabetes mellitus (n = 31), hypertension (n = 30), hyperlipidemia (n = 27), chronic kidney disease stage 3 and above (n = 16), malignancy (n = 18), chemotherapy (n = 18), and autoimmune conditions (n = 7). Most patients had more than 1 of these comorbidities (n = 45). Blood cultures were taken for most patients (n = 42). Among those with blood cultures, many had systemic bacteremia (n = 27), which was determined by a positive blood culture result. An ultrasound study was conducted to visualize collections (n = 27).

Table 2 presents the surgical management of patients with peripheral vein thrombophlebitis of the upper extremity. Surgical management involved debridement, which included the excision of the surrounding necrotic tissue and drainage of the pus collection until the healthy tissue was visualized (n = 51). The surgical approach employed in most patients involved an extensile incision (n = 50) in those with several morbidity factors (diabetes mellitus, chronic kidney disease, and bacteremia). One patient presented with severe clinical signs of local infection and on exploration, there was intraluminal pus and a thrombus up to 10 cm. A novel technique of a minimally invasive approach of intermittent stab incisions was employed in a young and healthy patient.

Ligation of the thrombosed segment of the vein proximally and distally and excision were performed (n = 36). The length of the double ligation of the vein was determined based on the extent of the intraluminal thrombus or pus. Intraoperatively, there was a predominance of intraluminal thrombus (n = 41) and pus (n = 24), with a minority having pus present beyond the vessel or extending proximally (n = 15). Most patients had primary closure (n = 25) or secondary closure (n = 24). Most patients underwent 1 (n = 24) or 2 (n = 21) operations, and only a minority underwent 3 (n = 4) or 4 (n = 2) operations.

All patients received antibiotics before surgery and had samples obtained for intraoperative tissue cultures. Intraoperative tissue cultures revealed *Staphylococcus aureus* (n = 34) as the causative microorganism; most patients had bacterial growth in their cultures (n = 38), and histology was obtained (n = 27).

All patients were followed up as inpatients until they had a resolution of infection and their wounds were well healed. The length of follow-up was over an average of 11 days and up to 33 days during the patient's hospitalization until their infection was assessed to have been resolved by the Hand Surgery team. The

**Table 2**  
Surgical Management of Patient With Peripheral Vein Thrombophlebitis of the Upper Extremity, N = 51

Variable	Frequency (%)
Tissue culture	
<i>S aureus</i>	67
<i>Klebsiella pneumoniae</i>	4
<i>Enterobacter cloacae</i>	2
<i>Pseudomonas aeruginosa</i>	2
<i>Escherichia coli</i>	2
No bacterial growth	23
Operative procedure	
Excisional debridement	100
Excision and ligation of the vein	71
Intraoperative findings	
Presence of pus within the vein	47
Presence of thrombus within the vein	80
Pus present beyond the vein or extended proximally	29
Wound closure	
Primary closure	49
Secondary closure	47
Secondary intention	4
Histology	55

**Table 3**  
Proposed Indications for Surgical Intervention\*

Proposed Indications for Surgical Intervention	
1. Clinical assessments highly suggest abscess formation with or without imaging evaluation, demonstrating abscess/systemic bacteremia (absolute indication)	
I. Clinical evaluation	Fluctuance, pus, appearance + abscess forming
(±) II. Imaging evaluation	Ultrasound demonstrates abscess
(±) III. Microbiological evaluation	Positive blood culture suggesting systemic bacteremia
2. Failure of conservative/appropriate antibiotics treatment to resolve in 48 hours (absolute indication)	
3. Patient comorbidities suggesting a lower threshold for surgical intervention (relative indication)	
	Intercurrent illness
	Diabetes mellitus
	Malignancy
	Chemotherapy
	Chronic kidney disease
	Immunocompromised

\* This is a proposed indication for surgical intervention, and the decision for surgery would ultimately be at the surgeon's discretion. Note that not all criteria have to be met for surgery to be indicated. Fulfillment of criteria 1 and 2 would be an absolute indication for surgical intervention. However, for a patient who fulfills criteria 1 and 3 but has yet to fulfill criteria 2, early surgical intervention could be considered if thrombophlebitis is deemed unlikely to resolve conservatively. For criteria 1 clinical assessment suggesting abscess formation, this is first based on I. Clinical evaluation for fluctuance, pus, and appearance is highly suggestive of abscess formation. However, if there is ambiguity regarding abscess formation on clinical evaluation, imaging evaluation with ultrasound could be performed to confirm abscess formation. Blood cultures can be taken based on clinical assessment, such as when the patient develops a fever with a temperature of more than 38 °C. It can take up to 5 days to obtain a positive blood culture result that suggests systemic bacteremia, and the decision to intervene surgically should not be delayed if deemed necessary. Nonetheless, the presence of a positive blood culture would entail a greater urgency for surgical intervention if criteria 1 and 2 are fulfilled.

clinical measure to determine whether the treatment was successful was the resolution of thrombophlebitis. This was mainly based on the clinical assessment of resolving pain, erythema, swelling, pyrexia, and the absence of pus or discharge during wound inspection.

#### Extensile incision

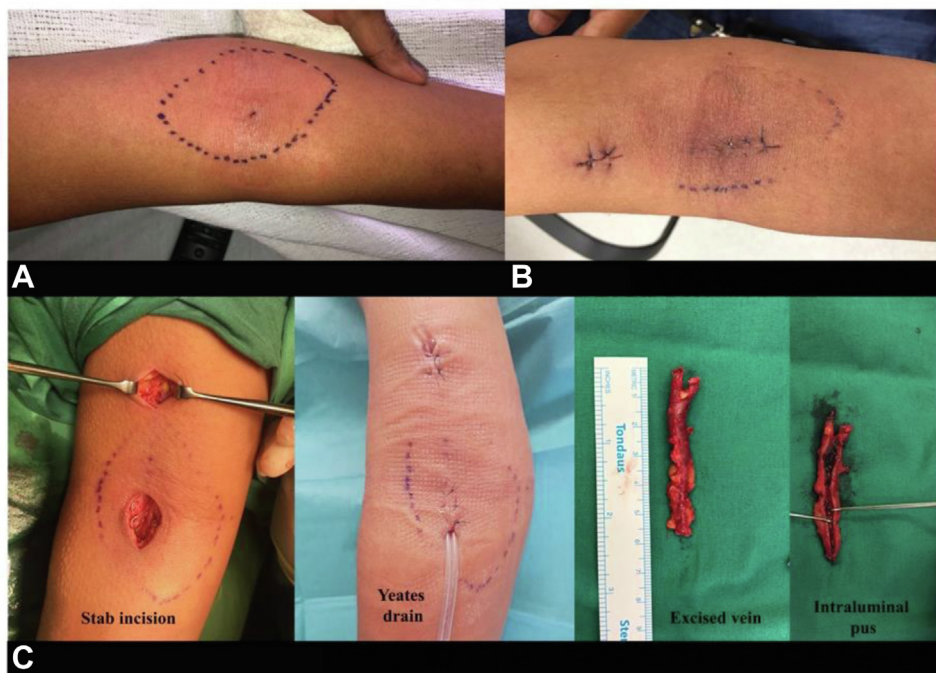
The following case illustrates the surgical approach of extensile incision employed in most patients. A 76-year-old woman with a background of poorly controlled diabetes mellitus, hypertension, hyperlipidemia, and stage 4 chronic kidney disease was admitted for herpes zoster ophthalmicus. She developed pain and swelling 2 days after the insertion of an intravenous plug over the dorsum of her right wrist. Clinically, the intravenous line had been removed, but the plug site was swollen and tender, with a large area of induration extending along the forearm to the antecubital fossa. This was associated with fever and methicillin-sensitive *S aureus* bacteremia. An ultrasound of her right forearm demonstrated edema and a lobulated subcutaneous abscess measuring 1.3 × 0.9 × 0.4 cm.

The clinical impression was that of right forearm thrombophlebitis with localized abscess formation complicated by severe cellulitis. The patient was then taken to the operating room for excisional debridement of her right forearm with the ligation of the cephalic vein proximally and distally under general anesthesia. Intraoperatively, an elliptical incision was made incorporating the initial puncture site. An extensile incision was then made distally and proximally along the cephalic vein up to 10 cm, guided by the extent of palpable and visible intraluminal pus and thrombosis. The length of the cephalic vein to be excised and ligated was judged as being until the point where there was no further pus or intraluminal thrombus visualized. The side branches of the veins were not excised, but the surrounding necrotic tissue was excised. A Yeates drain was inserted and removed on postoperative day 2. The histology findings were consistent with the clinical suspicion that the primary problem was thrombophlebitis. The microscopic description revealed transverse sections of a thick-walled blood vessel with a large number of neutrophils in the vessel wall and surrounding fibroadipose tissue. There was an organizing thrombus within the vessel lumen admixed with marked neutrophilic exudate. The

## Case 1



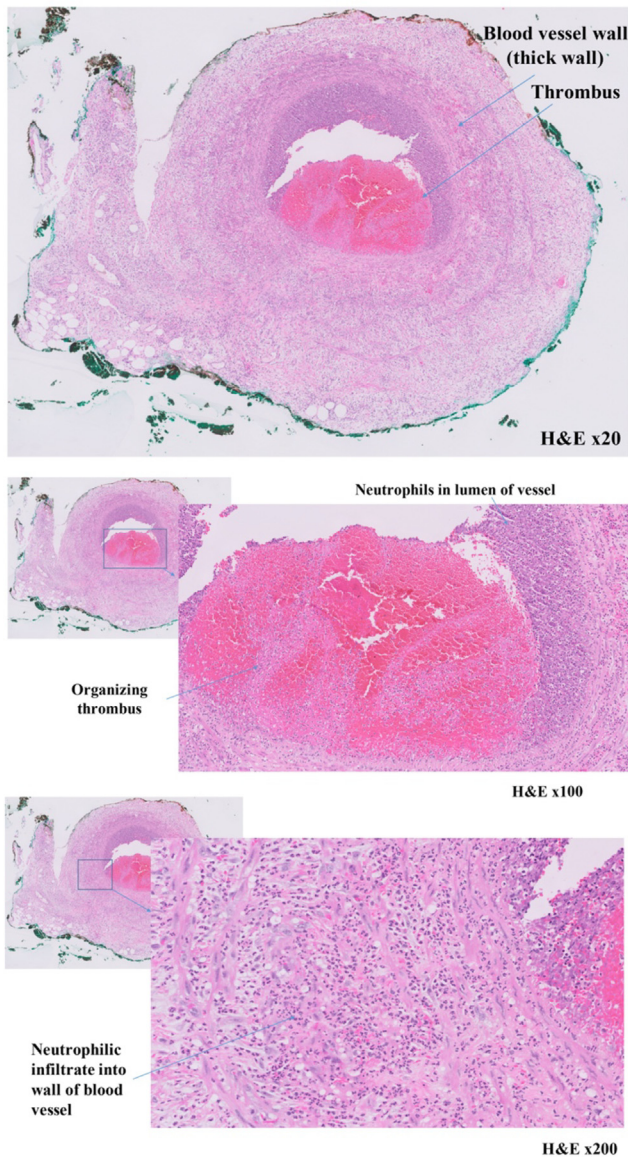
## Case 2



**Figure 1.** Illustrations of case 1 involving an extensile incision and case 2 involving stab incisions. **A** Preoperative photograph. **B** Postoperative photograph. **C** Intraoperative photograph.

appearances were interpreted as the infection and inflammatory infiltrate having arisen from the thrombosed vein with a super-added bacterial infection. Intravenous cefazolin was administered

for 8 days and converted to oral linezolid for 1 week on discharge. The infection was resolved clinically, and the wound was well healed.



**Figure 2.** Histology of case 1. A 76-year-old woman with a background of poorly controlled diabetes mellitus, hypertension, hyperlipidemia, and stage 4 chronic kidney disease was admitted for herpes zoster ophthalmicus. She developed right forearm thrombophlebitis with localized abscess formation complicated by methicillin-sensitive *S aureus* bacteremia. Microscopic description revealed transverse sections of a thick-walled blood vessel with a large number of neutrophils in the vessel wall and surrounding fibroadipose tissue. There was an organizing thrombus within the vessel lumen admixed with marked neutrophilic exudate. The appearances were interpreted as the infection and inflammatory infiltrate having arisen from the thrombosed vein with superadded bacterial infection (Hematoxylin-eosin stain; magnifications  $\times 20$ ,  $\times 100$ ,  $\times 200$ ).

In summary, this patient's large number of comorbidities probably lowered her resistance to infection. Surgery was indicated to manage a demonstrated purulent collection. It is not possible to determine whether the systemic bacteremia was a cause or a consequence of the venous line insertion.

The preoperative, intraoperative, and postoperative photographs are presented in Figure 1. The histology is shown in Figure 2.

#### Minimally invasive approach

A novel technique of a minimally invasive approach was employed in a 51-year-old woman with no considerable medical

history. She was admitted for the surgical removal of cactus thorns in her left little finger and underwent wound exploration and removal of the foreign bodies under local anesthesia. There was no evidence of infection in the finger before or after surgery, and intraoperative cultures did not reveal any bacterial growth. She developed pain and swelling 3 days after the insertion of a 22-gauge intravenous plug in the emergency department over her right antecubital fossa. Clinically, there was tenderness, erythema, induration, and a palpable cord associated with a low-grade fever of  $37.7^{\circ}\text{C}$ , despite being pretreated with intravenous coamoxiclav for 3 days. As the patient had already been treated with antibiotics, her blood cultures may not have revealed any bacterial growth to suggest systemic bacteremia. The clinical impression was that of the right antecubital fossa thrombophlebitis.

The patient was then taken to the operating room for excision debridement of her right antecubital fossa with excision and ligation of the cephalic vein under wide awake local anesthesia no tourniquet technique. A minimally invasive approach was employed. It involved 2 separate stab incisions made proximally and distally based on the course of the tenderness marked before surgery. The vein was also palpated to determine where it appeared patent. Intraoperatively, the thrombosed segment of the vein was ligated proximally and distally, corresponding to the sites of the 2 stab incisions and then excised. The excised vein was removed by avulsion. This was the portion of the vein the intraluminal thrombus was evaluated to be contained within based on preoperative assessment of tenderness and patency of the vein. The excised vein was evaluated to check whether the intraluminal thrombus was contained entirely within. As the intraluminal thrombus was contained entirely within the excised vein, the ligation and excision were not extended further. There was no pus visualized intraluminally or beyond the vessel.

The wound was closed over the 2 stab incisions with a Yeates drain, which was subsequently removed on postoperative day 1. Intravenous coamoxiclav was administered for 5 days and converted to oral coamoxiclav for 1 week on discharge. Intraoperative tissue cultures did not reveal any bacterial growth. The histology findings were consistent with thrombophlebitis. The microscopic description showed a vein with an intraluminal organizing thrombus. There was an admixture of acute inflammatory infiltrate rich in neutrophils within the thrombus and wall of the vein. The infection was resolved, and the wound was well healed.

In summary, in the absence of comorbidities, the focus must be on the cannula site with the possibility of introducing infection on cannula insertion or movement of the cannula because of placement over the elbow joint without immobilization by splintage.

The preoperative, intraoperative, and postoperative photographs are shown in Figure 1.

#### Discussion

Peripheral vein thrombophlebitis has been recognized as a clinical problem for the past 50 years and is associated with high morbidity and mortality.<sup>2,3,5</sup> However, it remains an ongoing challenge with no consensus on the indications for surgical intervention and management.<sup>1,6,7</sup> This is partly because of the difficulties in quantifying the extent of infection and the difficulties in designing a randomized trial. This study is a retrospective review in which thrombophlebitis was effectively managed surgically. The authors of this article are hand surgeons who are highly experienced in the management of septic conditions involving the upper extremity, including the surgical management of thrombophlebitis. An extensive literature search on thrombophlebitis has been undertaken, and a systematic review has been published.<sup>12,13</sup>

**Table 4**  
Proposed Surgical Approach

Surgical Approach	
1. Preoperative - Palpate to delineate the area of tenderness, fluctuance, and patency of the vein	
2. Intraoperative	
I. Incisions	Extensile, stab
II. Ligation and excision of the vein	
i. Length of the affected vein to be ligated and excised based on	
- Preoperative assessment of tenderness, fluctuance, and patency of the vein	
- Stab incisions may be considered to demarcate the extent of intraluminal thrombus/pus before avulsing the affected vein	
ii. Perform double ligation of the affected vein proximally and distally and excision	
iii. After resection, ensure that the thrombus/pus is contained entirely within the excised vein by milking both proximally and distally from the unexcised veins. If thrombus/pus is present, extend the ligation and excision of the vein	
III. Excise necrotic tissue, drain pus surrounding vein till the healthy tissue is visualized	
IV. Secondary closure is used	
V. Investigations	Pus or tissue cultures to guide antibiotics therapy Histology to confirm the diagnosis
3. Postoperative - Failure of infection to resolve clinically at 48 hours after surgery may warrant another surgery	

### Indications for surgical intervention

Intravenous lines are used by various specialist groups, and it would be helpful to have guidelines indicating when surgical opinion should be considered. Based on a review of the literature, there is 1 available guideline on the indications for surgical intervention. The indications are vague and do not allow prompt diagnosis or surgical intervention.

Surgical resection of the involved vein is recommended in patients with suppurative thrombophlebitis and those who failed conservative therapy according to the Infectious Disease Society of America clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection in 2009.<sup>2</sup> Suppurative thrombophlebitis requires the presence of positive blood culture results and the demonstration of a thrombus by radiographic testing. It has been proposed that this condition should be suspected in patients with persistent bacteremia or fungemia. This is defined as patients whose blood culture results remain positive after 3 days of adequate antimicrobial therapy without another source of intravascular infection. However, this diagnostic approach would not be timely because it would translate into 5 days of observation before establishing the diagnosis and result in a delay in surgical intervention.

Based on our study and the best available evidence, we have developed an algorithm to guide the indications for surgical intervention and approach in patients with thrombophlebitis.<sup>1–3</sup> This algorithm can be found in Tables 3 and 4.

Surgical intervention should be considered in a select group of patients who develop thrombophlebitis with the clinical suspicion of abscess formation. This is guided by the presence of local signs of abscess such as the presence of fluctuance or pus on clinical evaluation. Other clinical indicators of an abscess may include the usual local symptoms and signs of infection such as pain, swelling, erythema, induration, pyrexia, or palpable cord. The role of laboratory evaluation is limited. Although inflammatory markers such as white cell counts and C-reactive protein levels are sensitive in infection, they may not be specific for thrombophlebitis. In this study, there was a considerable number of patients with intercurrent illness (n = 27); thus, elevated inflammatory markers may not be solely attributable to thrombophlebitis. Furthermore, these patients had comorbidities, including malignancy (n = 18), chemotherapy (n = 18), chronic kidney disease (n = 16), and diabetes

mellitus (n = 31), which made them immunocompromised. These individuals were unable to mount a response to infection and were not likely to have elevated white blood cell counts even if they had an active infection.<sup>12</sup>

When there is ambiguity regarding the presence of an abscess, further evaluation may be performed radiologically with an ultrasound study to visualize for collection. Systematic bacteremia should also be excluded with blood cultures. However, these investigations should not delay surgical intervention when there is a high clinical suspicion of thrombophlebitis with abscess formation.

Failure to resolve infection clinically with appropriate antibiotic treatment within 48 hours should also warrant surgical intervention. This surgical indication is similarly supported by the Infectious Disease Society of America clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection in 2009.<sup>2</sup>

The threshold for surgical intervention should be lowered in patients with intercurrent illness, comorbidities of diabetes mellitus, malignancy, chemotherapy, chronic kidney disease, and immunocompromised individuals. Although these factors have been demonstrated to predispose patients to thrombophlebitis, this is often an undervalued area.<sup>6,8,12,14–19</sup> Furthermore, these patients can have a benign clinical presentation and may not often present with local evidence of abscess at the catheter site.<sup>3</sup>

### Surgical approach

In 1979, Baker et al<sup>3</sup> described septic phlebitis as a neglected disease, and regrettably, this situation persists. Surgical options that have been well-established include debridement of the underlying pus and thrombus, complete excision, and ligation of the involved vein and collaterals.<sup>20,21</sup> In addition, secondary closure of the wound has been recommended.<sup>2,3</sup>

Before surgery, the area of tenderness, fluctuance, and patency of the affected vein should be delineated by clinical assessment and imaging in playing an increasing role. This will guide the length of the affected vein to be ligated and excised intraoperatively.

Intraoperatively, both extensile and stab incisions may be considered. Conventional management for drainage of infection usually involves an extensile incision over the area of maximal tenderness.<sup>22</sup> Alternatively, a minimally invasive approach with intermittent stab incisions along the course of tenderness or

fluctuance can be made to delineate the extent of intraluminal thrombus or pus before avulsing the affected vein. Stab incisions may limit the extent of surgery and subsequent scarring in less severe cases. This is a novel technique that similarly leads to the resolution of infection.

Thrombosed sections of the vein should be ligated proximally and distally and excised. The proximal and distal unexcised veins could be traced and explored within to determine whether the thrombus or pus is contained entirely within the excised vein. If the thrombus or pus were observed from the vessel ends, there would be a need to extend the ligation and excision of the vein to achieve good source control.

Any surrounding necrotic tissue should be excised, and collections of pus should be drained until the healthy tissue is visualized. Thorough irrigation should be performed. Drain insertion may be considered. Delayed secondary wound closure is usual. Pus and tissues should be sent for cultures to guide antibiotic therapy and to obtain histological diagnosis. After surgery, failure of the resolution of infection clinically in 48 hours may warrant a repeat surgery.

The absence of pus intraoperatively does not preclude a severe episode of thrombophlebitis, as thrombophlebitis can have benign manifestations in patients with sepsis.<sup>3</sup> Most patients who underwent surgical intervention had severe histological changes of thrombus, which was associated with the most severe damage to the veins.<sup>23,24</sup> Other severe histological changes included inflammation and edema of the vessel wall, heavy transmural neutrophilic infiltrate, fibrin thrombus within the lumen, necrosis of the vessel wall, focal organization and disruption of the wall, and hemorrhage. Mild histological changes involved occasional small clusters of lymphocytes noted around the small arterioles in the subcutis or thin, muscular venous wall tissue lined by fibrinopurulent exudate.<sup>23,24</sup>

In summary, a more extensive surgical approach was employed in most patients. It involved an extensile incision for patients with several comorbidities, such as diabetes mellitus, chronic kidney disease, and bacteremia. One patient presented with severe thrombophlebitis with intraluminal pus and thrombus up to 10 cm. A minimally invasive surgical approach with a novel technique of stab incisions was employed in a younger and healthy patient. Stab incisions are more beneficial for wound healing because of a smaller wound and give rise to a more aesthetically pleasing wound. Both techniques described provided adequate source control and led to the resolution of the infection.

Despite the strengths of our study, there are several limitations that can be addressed with future research. Because of the small sample size and the fact that this is a retrospective observational study, this is only representative of the study population at a single point. Multivariate logistic regression analysis could not be performed to adjust for confounding factors. There were no patient-reported outcomes. This was because the patients were followed up as inpatients until the resolution of their infection, which was confirmed on the basis of an objective clinical assessment by the Hand Surgery team. Areas that can be further improved include studies to investigate the novel technique of intermittent stab incisions to manage thrombophlebitis, an experimental approach to establish intravenous lines such as setting up plugs in the operating rooms in sterile environments, and the consideration of splintage in

adult practice.<sup>13</sup> This will allow for more refined and targeted surgical management of this iatrogenic infection.

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