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The clinical relevance of the sleeve



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The fibroblastic sleeve

The fibroblastic sleeve (erroneously called ‘fibrin sleeve’, though its fibrin content is minimal) is a most neglected phenomenon.

Even vascular access experts often ignore the existence of this connective tissue that progressively envelops the catheters.



The fibroblastic sleeve, the neglected complication of venous access devices: A narrative review

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Abstract

The presence of a vascular access device (or of any intravascular foreign body) inside the bloodstream is often associated with the formation of a connective tissue sleeve around the catheter (often named—erroneously—“fibrin sleeve”). Such sleeve is usually a physiological phenomenon with little or no clinical relevance, but its pathogenesis is still unclear, so that it is frequently confused with venous thrombosis; also, its relationship with other major catheter-related complications, such as venous thrombosis and bloodstream infection, is uncertain. This narrative review tries to convey in a systematic form the current knowledge about pathogenesis, incidence, clinical manifestations, diagnosis, and management of this phenomenon.

The fibroblastic sleeve

- The sleeve mainly consists of fibroblasts, smooth muscle cells, and collagen
- The FS is the physiological response of the blood to any foreign body placed inside the vessels.
- It develops slowly and usually it becomes evident at ultrasound after one week, as an incomplete hyperechoic sleeve of 1 mm or more all around the catheter.

The clinical relevance of the fibroblastic sleeve

Its clinical relevance is normally negligible, with some exceptions:

- It may (*rarely*) cause catheter malfunction
- It may (*very rarely*) cause difficulty in catheter removal or in placement of a new catheter
- It may (*frequently*) cause mismanagement of the patient because erroneously interpreted as thrombosis

FS and catheter malfunction

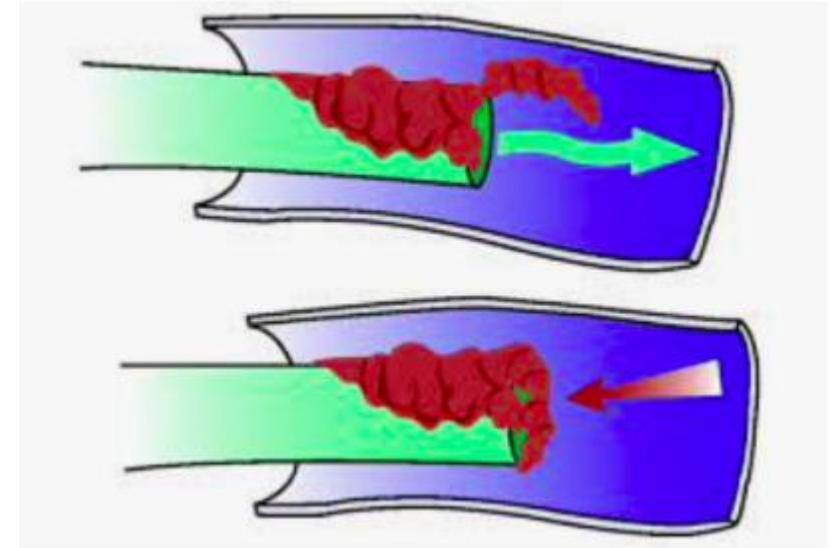
FS and catheter malfunction

A fully developed fibroblastic sleeve enwrapping the tip of the catheter may cause persistent withdrawal occlusion or other types of malfunction.

This happens after the FS has surrounded the tip of the catheter.

FS and catheter malfunction

The FS enveloping the tip may act as a unidirectional valve, causing difficulty in infusion and/or difficulty in aspiration.



A malfunction typically caused by FS is the so-called “persistent withdrawal occlusion” (PWO), characterized by a non-transitory impossibility of aspirating blood, though infusion remains feasible.

FS and catheter malfunction

Particularly prone to FS-related PWO are:

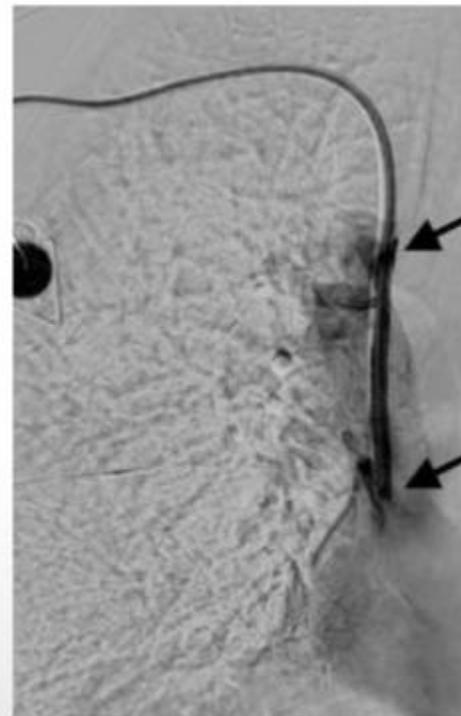
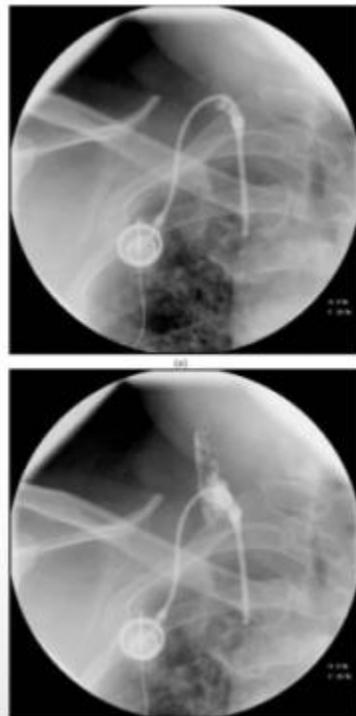
- Short catheters staying in place > 1 week (long peripheral catheters; pediatric CICC; etc.)
- Long term catheters used intermittently (dialysis catheters; ports; etc.)
- Close-ended catheters with distal valve (Groshong)

FS and catheter malfunction

- Though, PWO might be theoretically associated with other five causes:
 - pinch-off syndrome, with compression of the catheter between the clavicle and the first rib;
 - a malposition, with the tip of the catheter stuck into the vein wall or in a small secondary vessel;
 - the presence of a Groshong valve, which is often associated with difficult opening of the valve in aspiration, even in absence of a sleeve;
 - a catheter-related thrombosis that surrounds the tip of the VAD;
 - or (rarely) the presence of a clot at the tip of the catheter, obstructing it with a ball-valve mechanism.

FS and catheter malfunction

In the past, the diagnosis of a FS-related PWO was obtained by a line-o-gram (accurate, but invasive and expensive)



FS and catheter malfunction

Today, considering (a) that the **pinch-off syndrome** is exclusively related to the antiquate and dangerous technique of 'blind' subclavian venipuncture, currently abandoned in our hospital, and (b) that **Groshong catheters** are inappropriate and obsolete (and we stopped using them a decade ago), when PWO of a central line occurs, we assess the correct placement and functionality of the catheter using the ECHOTIP with bubble test.

FS and catheter malfunction

Techniques in vascular access

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An ultrasound-based technique in the management of totally implantable venous access devices with persistent withdrawal occlusion

**Sonia D'Arrigo¹ , Maria Giuseppina Annetta¹
and Mauro Pittiruti² **

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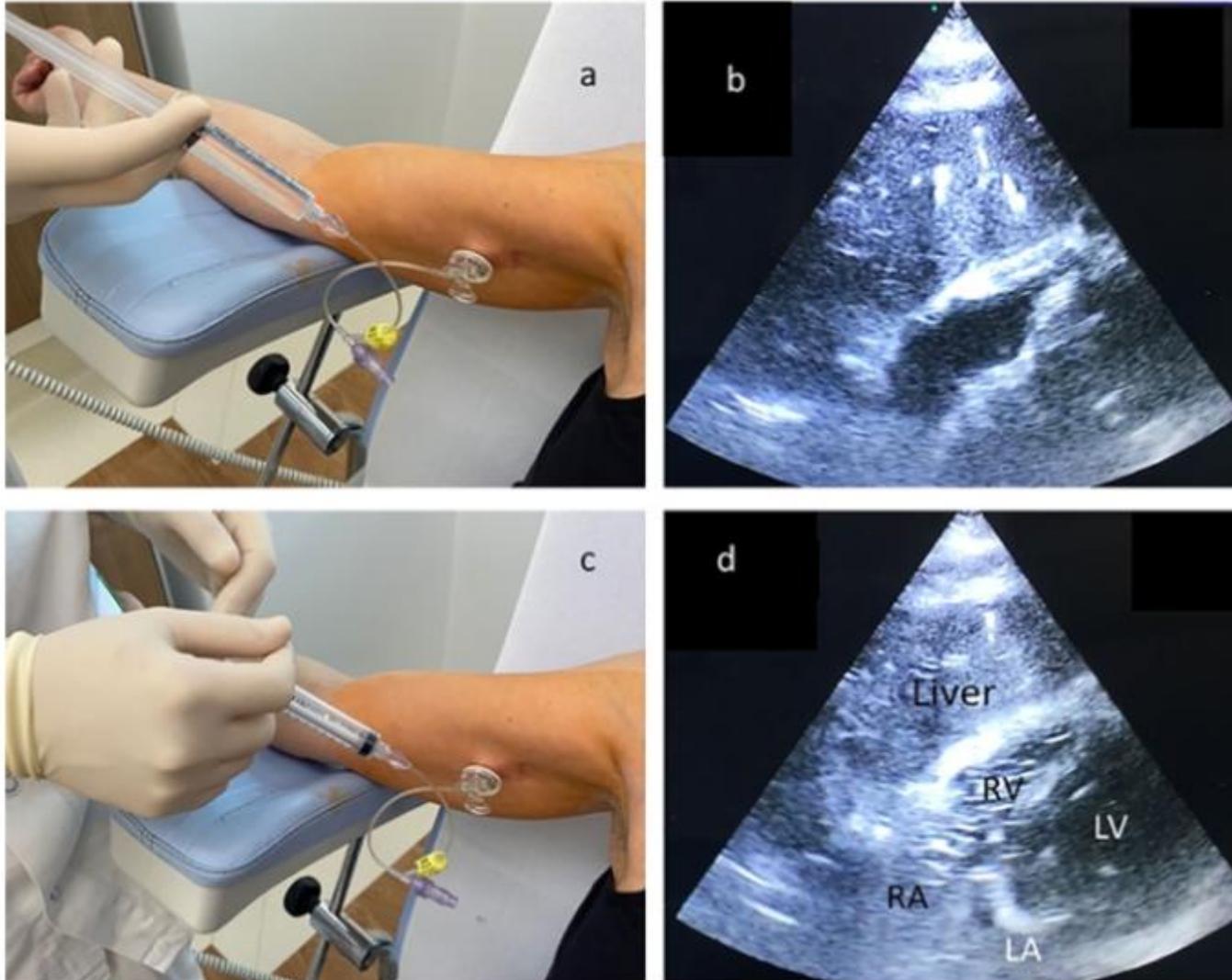
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FS and catheter malfunction



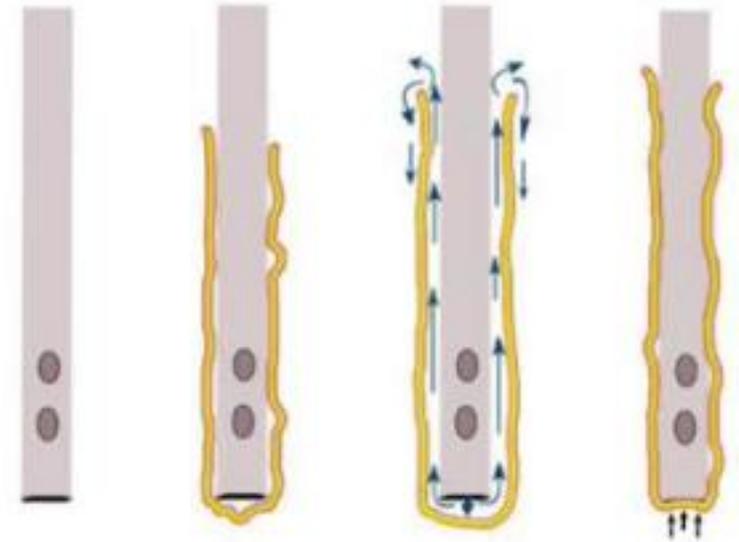
The immediate appearance of the bubbles excludes a malposition of the tip and the presence of a distal thrombosis, allowing a safe use of the line.

FS and catheter malfunction

The percentage of catheter malfunction that is actually related to FS is unknown, due to a lack of uniform definition of the FS. In tunneled-cuffed dialysis catheters in silicone, some malfunction potentially related to FS has been reported in 13%–57% of cases.

FS and catheter malfunction

When the FS has completely wrapped the catheter tip, it may cause a complete obstacle: the infusate may not find its way into the bloodstream, but it may be pushed back into the cleavage between the catheter and the inner surface of the FS, with the risk of extravasation at the exit site (for non-tunneled VADs), inside the tunnel (for tunneled VADs), or inside the pocket of the reservoir (for totally implantable VADs). Such extravasation may be associated with severe tissue damage, if the infused drugs are vesicant.



FS and catheter malfunction

The incidence of extravasation or infiltration due to FS has not been defined. However, this event is probably more likely to occur with short catheters (5–10cm) which stay in place for 2 weeks or more, such as long peripheral venous catheters (so called “mini midline”) in adults and children, or centrally inserted central catheters (CICCs) in pediatric patients.

FS and catheter malfunction

In a recent prospective study on 254 PICCs in cancer patients, FS developed in 29.9% of cases, but it was never associated with PICC malfunction.

Original research article

Incidence of fibroblastic sleeve and of catheter-related venous thrombosis in peripherally inserted central catheters: A prospective study on oncological and hematological patients

Carmela Trezza¹, Catello Califano², Vincenzo Iovino³,
Carmela D'Ambrosio¹, Giuseppe Grimaldi⁴ and Mauro Pittiruti⁵ 

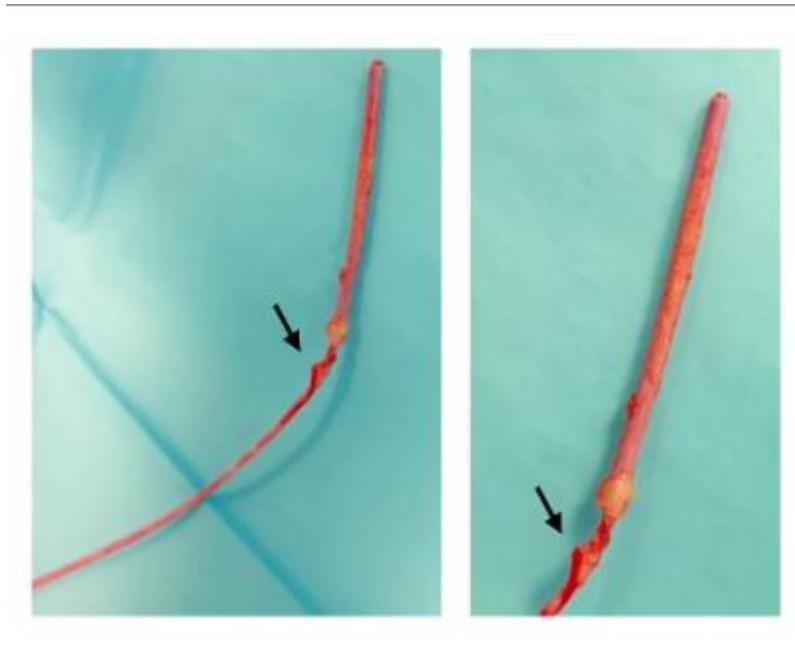
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FS and catheter removal

FS and catheter removal

The sleeve may cause difficult catheter removal; also, after catheter removal, the remnants of the FS may act as a mechanical obstacle to the insertion of a new catheter in the same vein.



FS and catheter removal

Recently, FS has been held responsible for cases of difficult removal of peripherally inserted central catheters (PICCs) in adult patients.

When removing a PICC, the sleeve may roll up around the catheter, in particular, in the tract where the catheter is in the small veins of the arm, and create some resistance to the removal, typically after the first 10–15 cm of withdrawal.

FS and catheter removal

This difficulty in PICC removal has been erroneously explained by a 'vasospasm' of the vein (phenomenon that does not exist, since the muscular layer of the small vein is not functional).

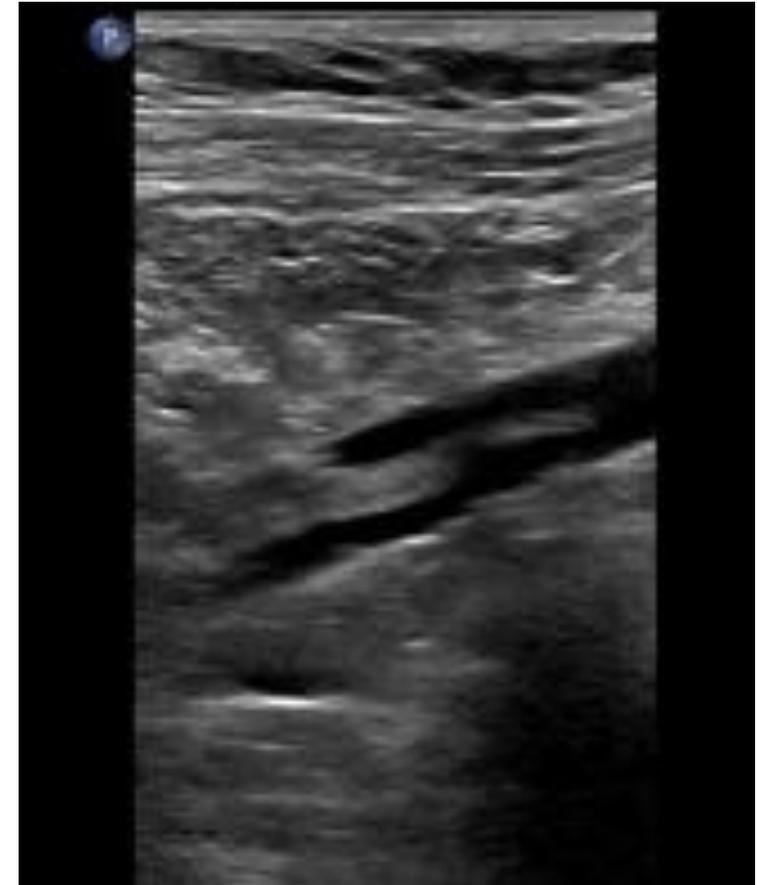
In such cases, the maneuver of inserting a 0.018" floppy straight-tip guidewire into the PICC and rotating catheter and guidewire together usually is successful, since it breaks possible adhesions between the catheter and sleeve.

Though, the adherences of the FS often dissolve spontaneously after 24-48 hours.

FS and catheter removal

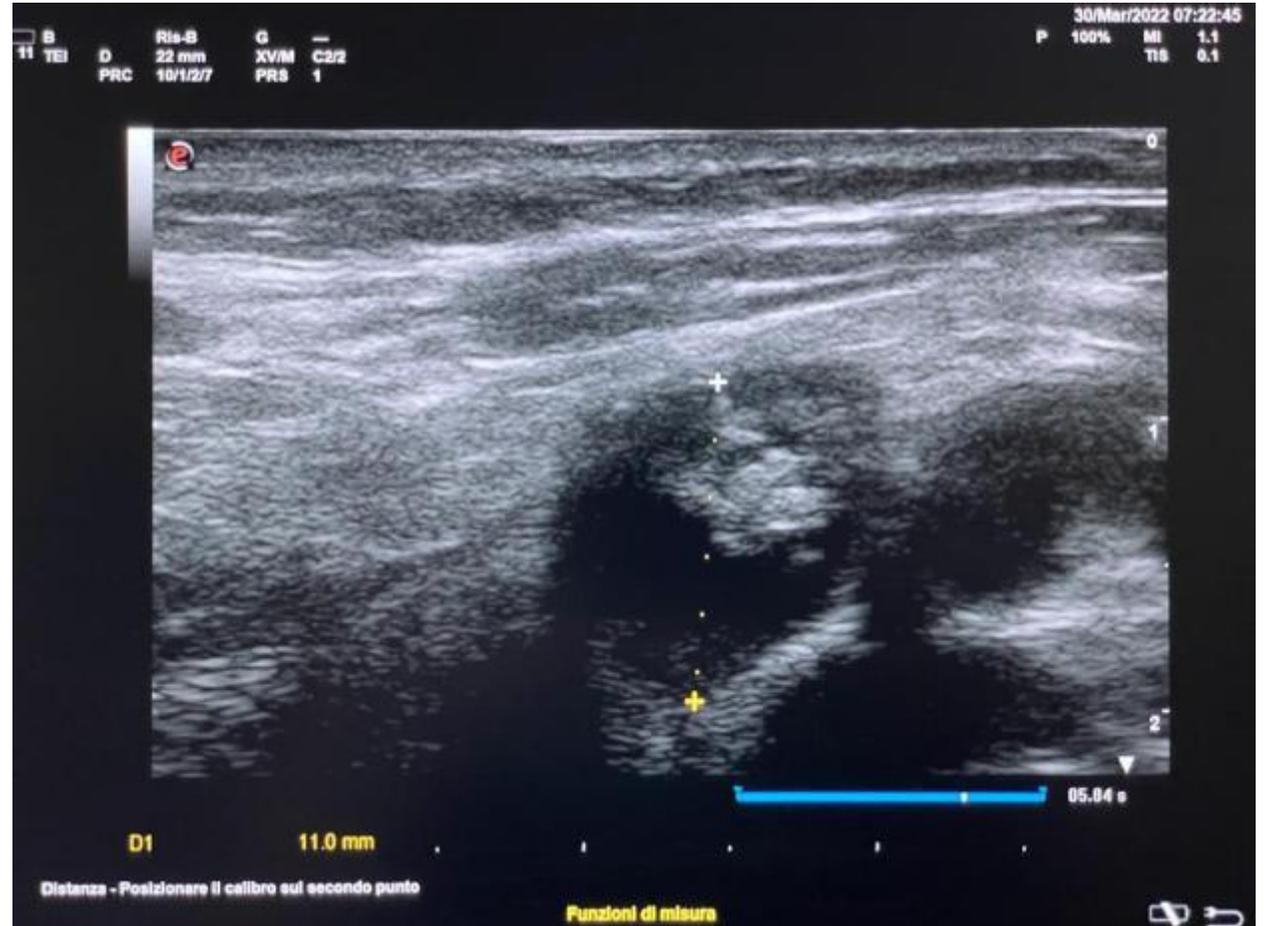
After catheter removal, FS persists inside the vein as a hyperchogenic image which may have the appearance of the catheter itself (so-called 'ghost of the catheter').

In dialysis catheters, a calcified persistent FS is often mistakenly interpreted as a residual catheter fragment.

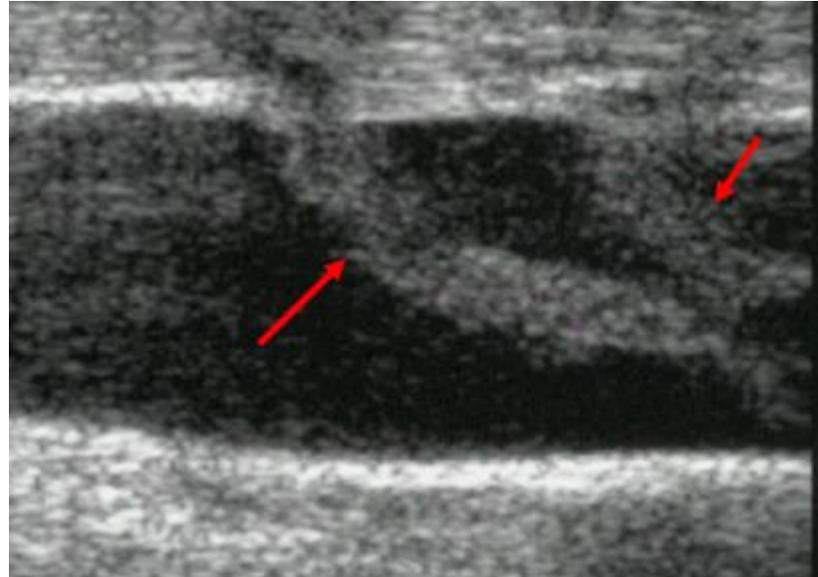


FS and catheter removal

The 'ghost of the catheter', occupying space inside the vessel, may act as an obstacle both in case of guidewire replacement and in case of placement of a new catheter in the same vein.



FS and catheter removal



FS and thrombosis

FS and thrombosis

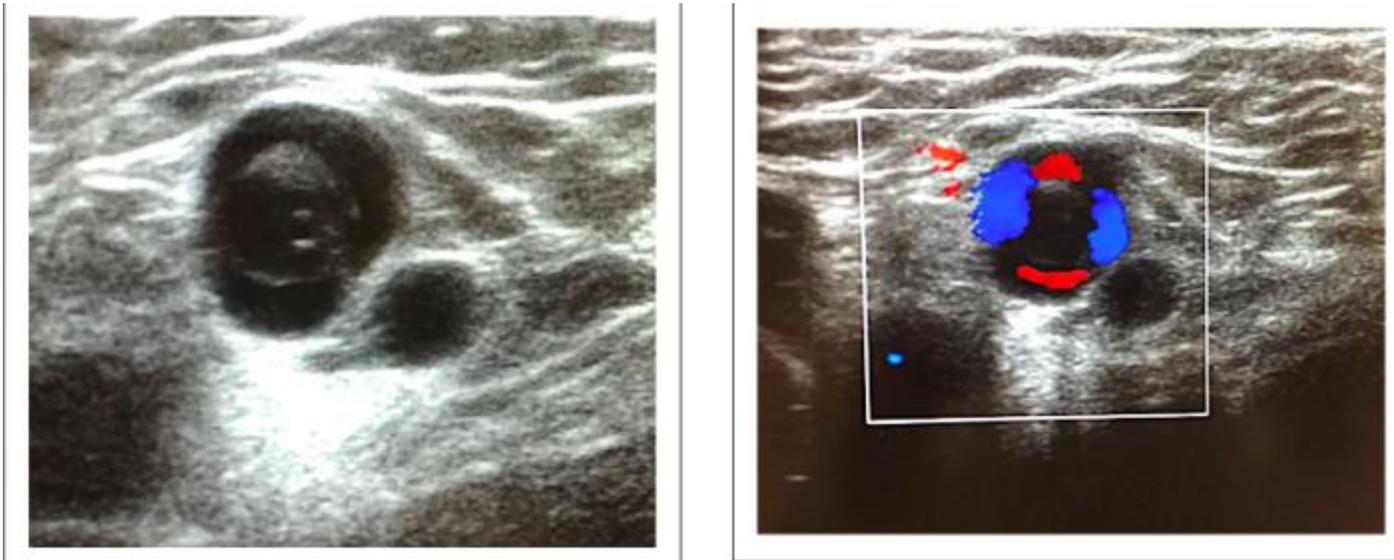
The sleeve is often mistakenly interpreted as asymptomatic thrombosis at ultrasound or CT scan, exposing the patient to the risks of an unnecessary anticoagulant treatment.



FS and thrombosis

Many operators commonly using ultrasound for the diagnosis of catheter-related complications still adopt the term “peri-catheter thrombosis” when they see echogenic material around the catheter.

The vast majority of these images interpreted ‘peri-catheter thrombosis’ – particularly if asymptomatic – are really sleeves.



FS and thrombosis

Also, the so-called 'fibrin tail' sometimes described at CT scan or at echocardiography consists in fragments of FS attached to the tip of the catheter.

FS and thrombosis

To avoid unnecessary – and potentially dangerous – antithrombotic treatment, it is necessary to be able to differentiate FS from asymptomatic thrombosis.

Table 3. Main differences between catheter-related thrombosis (CRT) and fibroblastic sleeve (FS).

	CRT	FS
Etiopathogenesis	Endothelial damage	Foreign body reaction
Molecular trigger	Tissue thromboplastin	Fibronectin
Type of tissue	Thrombus	Connective tissue
Location	At the site of vein wall damage	Around the catheter
Evolution	Fibrosis/reabsorption	Reabsorption (?)
US imaging	Mass obstructing the vein Anechoic, and then hypo-echoic Mainly attached to the vein wall	Sleeve all around the catheter Hypo- or hyper-echoic Mainly attached to the catheter
Clinical manifestation	Signs and symptoms of venous obstruction + risk of catheter malfunction	Catheter malfunction
Risk of pulmonary embolism	Yes	No
Need for VAD removal	Rare (not responsive to therapy)	Rare (irreversible catheter malfunction)
Preventable with anticoagulants	Yes (not consistently)	No
Sensitive to thrombolysis	Yes (in the initial phase)	No
Pharmacological management	LMW heparin	None

FS and thrombosis

Interestingly:

- Symptomatic thrombosis is far less frequent than asymptomatic thrombosis
- asymptomatic thrombosis is less frequent than FS
- There is no evidence of a correlation between FS and thrombosis

In the aforementioned prospective study on 254 PICCs:

- FS occurred in **29.9%** of patients
- Asymptomatic thrombosis in **5.12%**
- Symptomatic thrombosis in **0.39%**

Conclusions

Take home message

- Please acknowledge the existence of the fibroblastic sleeve!
 - Tell your colleagues
 - Tell your radiologists
 - Tell your ultrasound specialists
 - Tell everyone taking care of a patient with a central line

REMEMBER:

- Most of the 'asymptomatic thrombosis' are just FS: learn how to differentiate thrombosis and sleeve!

Thank you for your attention

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