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Mini Review

The Management of the Blood Withdrawal Difficulties in Venous Ports in Oncology

Viktor Manasek*

Department of Cardiology, Oncology Center of Agel Nový Jičín Hospital, Nový Jičín, Czech Republic

ABSTRACT

Venous port occlusion can be either partial, when infusion is usually possible but aspiration fails, or complete, when neither infusion nor aspiration can be performed. Persistent Withdrawal Occlusion (PWO) is a special entity, specifically a form of partial occlusion characterized by persistent or intermittent inability to perform aspiration. It is advisable to follow certain precautionary measures to maintain port patency. Venous occlusions can be divided into non-thrombotic and thrombotic occlusions; obliterations caused by the presence of a Fibroblastic Sleeve (FS) constitute a special group. Ignoring the PWO phenomenon entails a higher risk of drug administration outside the Cavoatrial Junction (CAJ), with potential extravasation in extreme cases. Medical staff must make sure that the drug administered into the port enters the blood stream near the CAJ, they should also ideally identify the cause of the PWO. In our original study, we focused on cancer patients with intravenous ports referred to the Cannulation Center of Agel Nový Jičín Hospital for PWO resolution. In the majority of cases, PWO was caused by the presence of FS, and after performing Mechanical Disruption (MD) using the rapid flush application to the port with a syringe of saline, venous return was restored in 53.5% of cases. Where this method failed, the patient was indicated for the administration of a plug with urokinase, or low-dose thrombolysis with alteplase (2 mg+50 ml from saline/2 hrs) was performed. After the administration of thrombolytics, the patency of 97.4% of all ports was restored.

Keywords: Fibroblastic sleeve; Persistent withdrawal occlusion; Venous ports; Anticancer treatment; Thrombolytics

INTRODUCTION

Adherence to the correct indication, recommended insertion procedures and optimal nursing care are the essential precautionary measures that can prevent occlusion. During catheter insertion, it is essential to respect any anatomical deviations of the vascular system, the patient's physique and to follow the recommended protocols for optimal catheter insertion [1-3]. When caring for the port, we follow the 3 principles, which consists in performing plentiful flushing with intermittent pulsatile application of the saline solution while maintaining a positive pressure in the catheter during the extraction of the port needle. In a study where albumin solution was administered and then its amounts in the catheter were measured after each type of flushing, intermittent pulsatile flushing was shown to be more effective than continuous infusion [4]. It has been shown in test models that the negative pressure generated when pulling the needle out of the port causes blood reflux and increases the risk of catheter occlusion. Application of positive pressure during needle withdrawal reduced the incidence of reflux during needle withdrawal by almost 80% (22% *vs.* 99%, $p<0.001$) [5]. Therefore, the extraction of the port needle under constant administration is recommended, which means that when the needle is properly withdrawn, a saline smear must be visible.

LITERATURE REVIEW

From a practical point of view, it is appropriate to divide occlusions into non-thrombotic and thrombotic occlusions. Fibroblastic occlusions are a special entity with a different etiology and therapeutic measures. Non-thrombotic causes

Correspondence to: Viktor Manasek, Department of Cardiology, Oncology Center of Agel Nový Jičín Hospital, Nový Jičín, Czech Republic, E-mail: viktor.manasek@nnj.agel.cz

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include mechanical occlusions and catheter obliteration with intraluminal persistence of substances (most often precipitates) that clog the catheter. It is always advisable to first rule out pseudomechanical occlusions, which are caused by an error in the use of the catheter or by a technical error. For ports it is advisable to reinsert the port needle, as the needle may have been placed incorrectly (at a bad angle, the needle may be short, etc.) or the needle may be defective. As far as the real mechanical causes of port occlusion are concerned, it is necessary to rule out kinking and especially impingement and pinch-off syndrome. This is caused by compression of the catheter between the clavicle and the first rib. Prolonged stress on the catheter may lead to its damage and subsequent detachment of the remaining portion of the catheter with its drifting further into the venous system, in extreme cases into the pulmonary system. Impingement syndrome occurs most often after the puncture of the subclavian vein from the central or midline access using a blind technique; with the introduction of ultrasound-guided puncture, the incidence of this complication has been significantly reduced. To detect the mechanical causes of occlusion, a careful examination, ultrasound, echocardiography is necessary and sometimes we cannot do without skiagraphy or fluoroscopy. Occlusions due to precipitation of drugs in the lumen of catheters represent another complication. Regarding thrombotic complications, a distinction should be made between thrombotic catheter occlusion, which is the result of improper manipulation with the port (most often inadequate flushing after blood collection or blood transfusion), and catheter-related thrombosis, in which, however, aspiration is often possible, and the symptoms of deep vein thrombosis predominate. FS is a special clinical entity, completely different from thrombosis. It represents a structured cellular tissue, more specifically connective tissue, developed by fibroblasts and smooth muscle cells, covered by a layer of endothelial cells (Figure 1) [6,7]. The medication is not administered into the cavoatrial junction but enters the venous system at the end of FS.

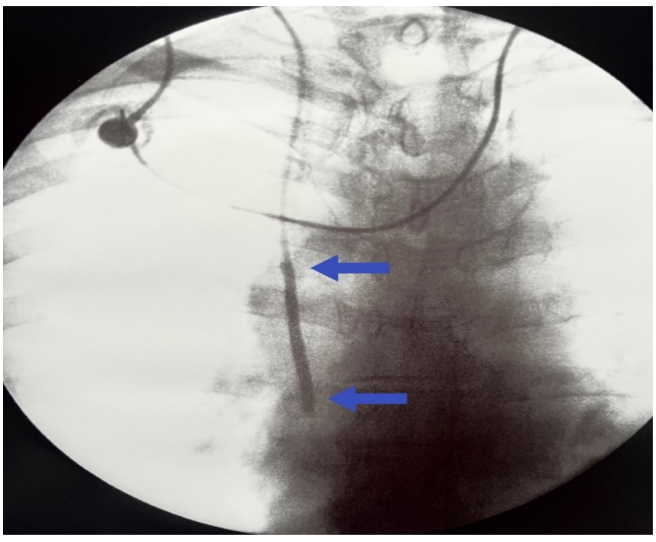

Figure 1: Fluoroscopy-after the administration of a contrast agent, an increase in the catheter width is evident, caused by the fibroblastic sleeve that extends from the distal tip of the catheter in a retrograde fashion (as indicated by arrows).

Over the course of 28 months (from September, 2020 to January, 2023), 177 cases of PWO in venous ports were managed in 117 patients. We evaluated the demographic data of the study group, and these were compared against those of the control group, consisted of 398 patients cannulated in the same period who did not develop PWO. Fluoroscopy with a contrast agent was performed in 87.1% of patients. Where contrast fluoroscopy could not be used, we performed echocardiography (to confirm the presence of the distal portion of the catheter in the superior vena cava) or a simple fluoroscopy with limited yield (usually in case of a negative echo to exclude secondary malposition). The presence of FS was clearly verified in 70% of cases in our study, the formation was probably below the resolution limit in the rest of the patients where no other pathology was detected. No specific diagnosis showed a higher tendency for FS creation on the catheter. The mean FS length was 5.57 cm (1-15 cm). MD resulted in restoration of blood return in 53.5% of cases. It has already been proven in earlier studies that mechanical injection of saline is a safe and effective way of restoring patency in ports [8,9].

FS represents the special feature of creating an "envelope" that "wraps" the catheter, it is a structured cellular tissue, more specifically connective tissue, developed by fibroblasts and smooth muscle cells, covered by a layer of endothelial cells. Although fibrin may initially happen to constitute part of this tissue, the main non-cellular component in the mature sleeve is collagen [6,7,10]. If FS is present and the tip of the catheter is affected, the applied solution may be pushed back into the cleavage between the catheter and the inner surface of the FS (Figure 2). This can lead to two outcomes. In the first case, the medication is not applied to cavoatrial junction, but enters the venous system at the end of FS. Then, depending on the length of FS, it usually enters the blood stream in the upper parts of the superior vena cava, brachiocephalic or subclavian veins. Further, there is also the risk of extravasation at the exit site (for non-tunnelled VADs), inside the tunnel (for tunnelled VADs), or inside the pocket of the reservoir (for totally implantable VADs).

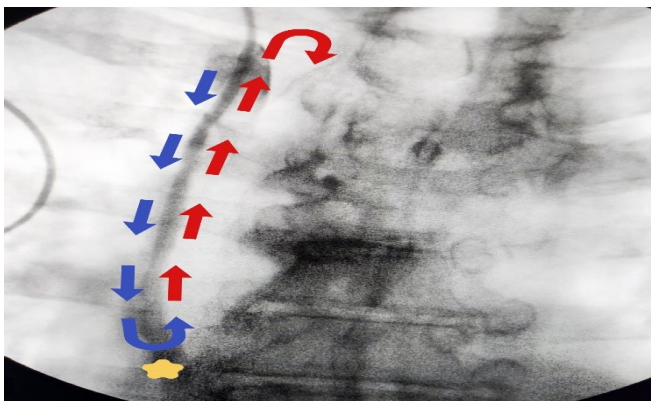

Figure 2: Fluoroscopy-fibroblastic sleeve with false route. The contrast agent is administered through the catheter (blue arrows), but it does not flow from the distal portion of the catheter into the cavoatrial junction due to catheter occlusion (marked by a yellow asterisk) and returns in a retrograde fashion through the space between the outer wall of the catheter and the inner surface of the sleeve (red arrows). It enters the venous system at the end of FS in the upper part of the superior vena cava, where cloud-like opacities can be seen.

DISCUSSION

A significantly shorter time to referral was demonstrated with successful MDs (median 1 week vs. median 4 weeks in unsuccessful MDs), p=0.006. Where blood return was not restored, we indicated the administration of a lock solution with urokinase or the administration of alteplase. The overall success rate of achieving desobliteration by MD alone or in combination with a thrombolytics was 97.4% [11].

It is obvious from the pathophysiological basis of the creation of the FS and its components that the administration of thrombolytics should have no effect as regards restoration of patency. However, in view of some smaller studies demonstrating the effect of thrombolytics, case reports and some cases of successful restoration of patency in venous access ports in clinical practice, we were wondering whether the irregular surface of a FS could not be conducive to the formation of microthrombi in the area of the distal portion of the catheter and whether these are not responsible for the creation of an occlusion [12-14]. In one older study, the authors examined the sleeves removed from dialysis catheters to determine their histopathology and detected the presence of a thrombus [15]. We obtained FS specimen after the catheter was pulled out and detected an older organizing thrombus in our study as well (Figures 3 and 4). The question is whether we can influence the factors leading to the development of FS and possibly the subsequent microthrombosis (while being aware of the merely theoretical level of this hypothesis).

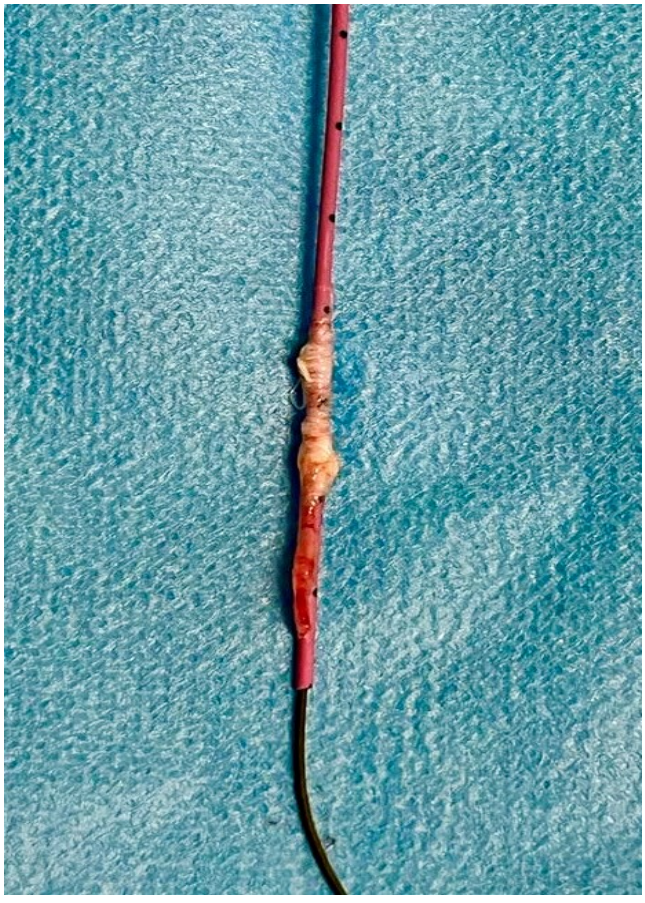

Figure 3: Fibroblastic sleeve on the catheter.

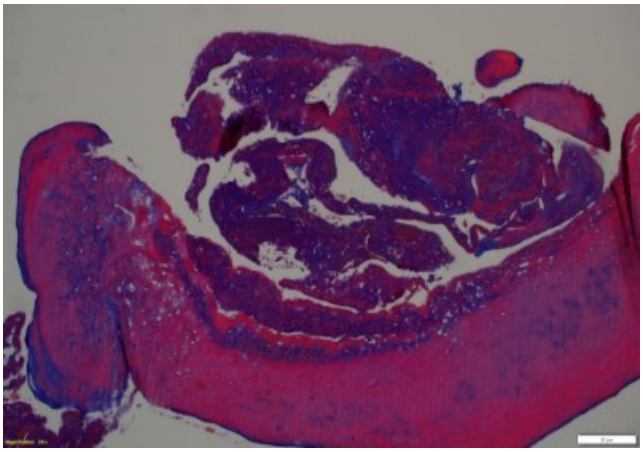

Figure 4: Histopathological image of fibroblastic sleeve with the presence of thrombus (Carstairs staining, 100x magnification).

CONCLUSION

Our goal is to keep the port functioning optimally for the entire time it is being used. In the event that blood return is not obtained from the port, the cause of the malfunction should always be determined. Detecting the cause of PWO in venous ports is essential for subsequent possibilities of management. The presence of FS is the most common cause of PWO. Based on the results of our project, we recommend attempting mechanical disruption by the flush method, which is the more effective the earlier it is performed. If the flush fails, a thrombolytic can be administered. This method for resolving PWO using mechanical disruption ± application of thrombolytics has had a 97.4% success rate. Current evidence has shown that FS is not likely to be affected by thrombolytic drugs. However, we have ascertained an effect of these drugs, proposing a hypothesis of microthrombotic events at the tip of the catheter if fibroblastic expansion is present. Further investigations are needed for a better understanding of the current topic.

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