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CASE REPORT

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Brachiocephalic Vein Stenting and Body-Floss Technique as a Treatment of CVD in Dialysis-Dependent Patient – Case Report and Literature Review

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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Summary

Background: Given the increasing number of elderly hemodialysis-dependent patients with concomitant chronic diseases the successful creation and maintenance of reliable vascular access become a real challenge. In current literature central vein disease (CVD) is defined as at least 50% narrowing up to total occlusion of central veins of the thorax including superior vena cava (SVC), brachiocephalic (BCV), subclavian (SCV) and internal jugular vein (IJV). The incidence of CVD has been reported to be as high as 23% in the total dialysis population and 41% in those with access related complains.

Case Report: 61-year-old man has been admitted to the local radiology department with symptoms of the superior vena cava syndrome. The venography revealed occlusion of the right brachiocephalic vein. Due to Tortuosity and lack of stamp of right subclavian vein contributed to the decision to perform recanalization by "body floss" technique. In a further step we have performed PTA of obstructed vein segment using 7×40 mm balloon. Due to the presence of residual stenosis it was decided to implant two self – expanding stents 10×40 mm. After the procedure the patient was discharged in good condition and transferred to dialysis center.

Conclusions: Main objective was the salvage of a functioning arteriovenous fistula. Performed endovascular intervention is a safe and effective approach to correct CVD for a short term. To ensure long lasting effects the patient will require enhanced follow-up and inevitable reinterventions. For that matter, prevention of CVD remains critical.

MeSH Keywords: **Arteriovenous Fistula • Radiology, Interventional • Renal Insufficiency, Chronic • Superior Vena Cava Syndrome**

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Background

Given the increasing number of elderly hemodialysis-dependent patients with concomitant chronic diseases the successful creation and maintenance of reliable vascular access has become a real challenge. Complications related to the access are a major cause of morbidity and mortality in the dialysis population. According to The Kidney Dialysis Outcomes Quality Initiative (K/DOQI) practice guidelines, autogenous arteriovenous fistula is considered the most beneficial form of long-term hemodialysis access with prosthetic grafts and tunneled catheters being far less desired [1]. Advantages of native fistulas, especially when located in the forearm, include longer cumulative patency, as well as lower incidence of complications [2]. Nevertheless, the access is vulnerable to multiple morphological and physiological shortcomings. Many fistulas are never able to sustain dialysis due to poor maturation or they fail early because of thrombosis and critical stenosis [3,4]. Moreover, placement of the fistula and the following

Figure 1. Occlusion of the right brachiocephalic vein.

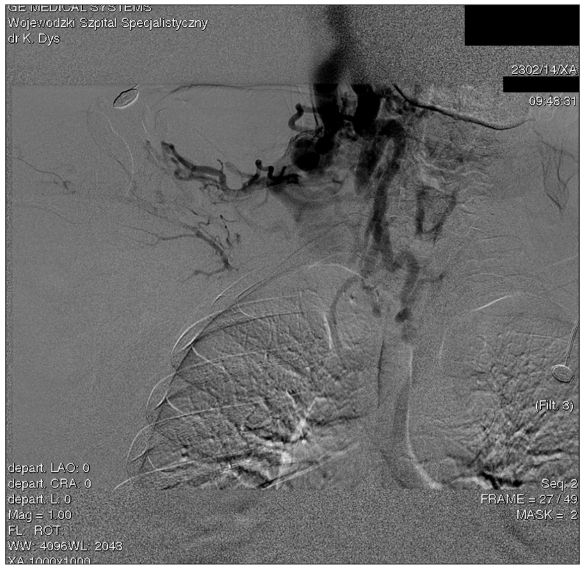

Figure 2. Significant collateral circulation.

haemodynamic changes may reveal hitherto occult impediment in the central vein.

In current literature, central vein disease (CVD) is defined as at least 50% narrowing up to total occlusion of central veins of the thorax including superior vena cava (SVC), brachiocephalic (BCV), subclavian (SCV) and internal jugular vein (IJV) [5]. The incidence of CVD has been reported to be as high as 23% in the total dialysis population and 41% in those with access-related complains [6]. Arteriovenous fistula relies on good venous outflow, therefore patients with ipsilateral venous stenosis and consequent venous hypertension are subject to the malfunctioning of the access. Development of superficial collateral veins and significantly diminished blood flow can lead to access occlusion due to thrombosis. Access recirculation results in inadequate dialysis delivery. Swelling of the arm may preclude cannulation. Unless the underlying CVD is dealt with, treating a failing fistula is often ineffective and may led to rethrombosis, aneurysmal dilation, and finally access loss.

Case Report

A 61-year-old man with chronic renal failure, type 2 diabetes, hypertension, obesity, and nicotine addiction (40 cigarettes per day) was admitted to the local radiology department with symptoms of the superior vena cava syndrome – face, neck, and arm edema on the right side. Venous hypertension as a consequence of central venous obstruction caused abnormal flow in the dialysis fistula on the right shoulder, making it impossible to conduct dialysis. The patient had been haemodialysed since November 2009. Medical history revealed significant difficulties with permanent vascular access creation. At first dialysis was performed by a permanent catheter located in the right internal jugular vein. In January 2010, an arterio-venous fistula was created in the cubital fossa. After ten months, the fistula developed thrombosis which was removed with thrombectomy. The initially normal flow was restored, but after two weeks it was necessary to obtain a new dialysis access. After two months, occlusion occurred in the

Figure 3. The VCS cannulated via femoral access.

fistula formed on the left shoulder. The proper flow was not obtained despite the performed thrombectomy. It was necessary to perform dialysis puncture on the right subclavian vein, and since then it was the only vascular access. In December 2010, there were another two failed attempts of creating a permanent vascular access – the right wrist and then the right arm. None of those fistulas functioned properly and they could not be used for dialysis. On the basis of ultrasound, stenosis of the right internal jugular vein with preserved flow and occlusion of the left internal jugular vein was found. Due to maintained flow in the right internal jugular vein, it was decided to place a permanent catheter in the lumen of that vessel. Performance of that procedure was impossible because of the presence of the catheter in the right subclavian vein, which was decided not to be removed due to the risk of loss of the only vascular access. Therefore, in March 2011 the patient received a permanent catheter in the right femoral vein. This allowed us to remove the right subclavian vein dialysis access and

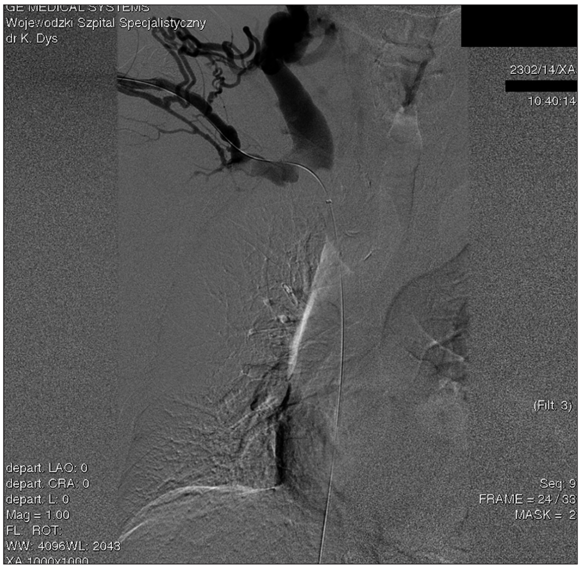

Figure 4. Body-floss technique – guide – wire in the vessel.

Figure 6. First stent implanted into the lumen of the BCV.

Figure 5. PTA of obstructed vein with 7×40 mm balloon.

Figure 7. Second stent implanted at the distal section of stenosis.

thus increased venous drainage of the right upper limb and restored function of the right shoulder AV fistula. Five months later the femoral vein catheter was removed and the patient was dialyzed by the fistula. The history and the patient's symptoms at admission suggested central venous obstruction, therefore the decision to perform venography was made. Using an angiographic needle, the operator punctured the dilated basilic vein, and introduced a 4F catheter. The examination revealed occlusion of the right brachiocephalic vein (Figure 1) with significant collateral circulation (Figure 2). Tortuosity and lack of stump of the right subclavian vein contributed to choosing the "body floss" technique as the most proper treatment method. Application of that technique required the creation of the second vascular access. The VCS was cannulated through the femoral access with 6F/90 cm (Figure 3). However, it failed to force through the occlusion from VCS, which led to the decision to re-approach from the basilic vein. A visible small stump of the right brachiocephalic vein was cannulated. Then the occluded section of the right brachiocephalic vein was overcome with a hydrophilic guidewire. In the next step, the guidewire was caught with a vascular loop located across the occlusion, placed in an introducer and drawn outside of the catheter (Figure 4). At that point, the rest of the procedure was performed from the femoral access. Further on, PTA (percutaneous transluminal angioplasty) of the obstructed vein segment was performed using a 7×40-mm balloon (Figure 5). Due to the presence of residual stenosis, it was decided to implant two self-expanding stents, 10×40 mm (Boston/Epic) in order to ensure proper vein patency. The first stent was implanted into the lumen of the brachiocephalic vein (Figure 6). Because of unsatisfactory flow, the operator decided to implant the second stent at the distal section of stenosis. To provide better stability and flow, its end was placed in the right subclavian vein (Figure 7). The stent crossed the lumen of the right internal jugular vein, but owing to the open-cell construction, blood flow was not disrupted. The post-dilation with balloons (9×20 mm and 10×40 mm) was performed. Control angiography showed correct brachiocephalic vein patency. After the procedure the patient was discharged in good condition and transferred to a dialysis center.

Discussion

According to a retrospective study of 235 prevalent hemodialysis patients, anatomic distribution of CVD is as follows: 38% at the subclavian-brachiocephalic vein junction, 29% in BCV, 24% in SVC, and 9% in SCV. Interestingly, no significant relationship was found between CVD incidence and age, gender, anticoagulation therapy or comorbid conditions such as diabetes, hypertension or peripheral vascular disease. The only statistically significant factors associated with CVD were history of multiple catheter insertions, cumulative dwell time, and site of catheter placement [6]. Association between central vein stenosis and indwelling intravascular devices – not only dialysis catheters but also peripherally inserted central catheters (PICC), venous ports and pacemaker/defibrillator wires – has been recognized for over two decades. The incidence of CVD induced by long-term tunneled cuffed catheters is reported to reach up to 42% after cannulation of the subclavian vein and to skyrocket even higher once the catheter became infected [7,8]. The figures are more modest for temporary catheters used for emergent dialysis needs but the correlation still holds [9].

CVD is believed to be induced by focal endothelial denudation from catheter insertion and following chronic irritation due to sliding movement of the catheter with respiration, postural or head movements, and the cardiac cycle, if the catheter tip is lodged in the right atrium. Vein wall thickening results from intimal hyperplasia with presence of fibrous tissue, smooth muscle proliferation and thrombi [10]. There is some scarce evidence of central vein stenosis in patients without a history of catheter placement. In such cases, CVD was reported to coincide with proximal location of vascular access with very high flow rates (mean 2347 mL/min) [11,12]. Apparently, arterialization of the blood flow created by the fistula itself produces enough damage to cause stenosis in at-risk patients.

The site of catheter placement is reported to be the key determinant for stenosis development. The likelihood of the latter ranges between 42% for SCV route and 10% for IJV route [6,8]. According to the current recommendations, the descending order regarding the preferred point of entry is as follows: internal jugular veins, external jugular veins, subclavian veins, femoral veins, and finally translumbar or transhepatic access to the inferior vena cava [1]. All else being equal, the right-sided vein is always preferred over its left-sided counterpart. Shorter and less tortuous route to the atrium results in limited contact between the device and the vessel wall. Nevertheless, all available studies indicate that cannulation of the central veins, regardless of the site, is associated with significantly increased frequency of CVD.

A high index of suspicion is necessary while managing hemodialysis patients with problems in obtaining and maintenance of the access. They require multiple catheter placement attempts in varying locations and for prolonged time, as it was the case in our patient. When patient's history and clinical examination indicates a high probability of stenosis, venography should be performed to confirm its presence and exact degree. Digital subtraction angiography (DSA) is still the gold standard for diagnosing CVD. It is superior to colorflow duplex ultrasound and completely safe for those already on dialysis.

If treatment proves necessary, The K/DOQI guidelines recommend percutaneous transluminal angioplasty (PTA), with or without stent deployment, as a method of choice [1]. It is important to note that endovascular intervention, while being far less invasive and complex then surgical alternatives, remains suboptimal approach to correct venous stenosis or occlusion. Angioplasty relies on endothelial disruption and intimal stretching. Hence, lurking restenosis renders the achieved results rather short-term [13]. In some cases, it can even exacerbate the very problem it was applied to solve. The point was demonstrated in a retrospective study evaluating 35 patients having 86 separate high-grade stenotic lesions with ipsilateral access malfunction but without pathognomonic arm, face or breast swelling. Data suggested that performing PTA was associated with more rapid progression of the stenosis and escalation of proliferative lesions when compared with a no-treatment approach [14]. Although the findings are somewhat inconclusive, they should encourage careful planning and restraint while dealing with CVD.

As far as our patient was concerned we had to adopt rather aggressive approach. We took into account not-too-advanced age of the patient (61 years) and the prospect of lifelong dialysis. Because of the noted problems with creation and maintenance of vascular access resulting in near-exhaustion of available access sites, we zeroed in on fistula salvage. Additionally, due to multiple catheter placement attempts, our patient was prone to develop bilateral central vein occlusion. At the time of intervention, left IJV and right BCV were confirmed as being affected. That in turn could eventually progress to produce a clinical picture of superior vena cava syndrome with all its debilitating symptoms.

Considering the location and extent of the lesion, with its distal margin difficult to pinpoint, we decided in favor of "through and through" wire procedure (bodyflossing). It involves two separate vascular access points and is typically applied when it is easier to guide recanalization and traverse the lesion from one site, while the other is the optimal route for balloon or stent introduction. The suboptimal result after PTA with a substantial residual stenosis prompted us to apply stents. It should be emphasized that in most patients primary stenting does not improve the patency rates when compared with PTA alone. Thus, the procedure should be reserved for recalcitrant cases [13]. Guidelines recommend placement of a stent for elastic lesions that lead to unresponsive residual stenosis exceeding 50% or for lesions recurring within 3 months after the intervention [1]. It is clearly evident that the presence of a stent in a vein incites early thrombosis as well as following intimal hyperplasia in and around the device. Hence, the length of the stent should ideally be as short as possible to cover the lesion only. That allows to limit vessel wall irritation and minimizes both early and delayed complications. We are also bound to anticipate future access sites before stent deployment, although it is technically possible to place the catheter through the meshwork of a stent.

The current literature demonstrates almost a hundred-percent technical success rate for stent placement but patency results are widely variable. The primary patency (time from the initial stenting to the next intervention) at 3, 6, and 12 months is 56 to 85%, 33 to 68%, and 14 to 33%, respectively. The secondary patency (time from the initial stenting to permanent vein occlusion) was estimated to range from 87 to 100% at 3 months, from 78 to 98% at 6 months, and from 55 to 67% at 12 months [15–17]. To sum up, the mean time to the first reintervention was reported to be 13.4 months and the average number of interventions in two years' time was 2.7 [17]. As indicated by the data, long-term symptomatic relief can be achieved only with multiple subsequent interventions. The results do not differ significantly between generations of self-expending stents. Nitinol stents, as the ones used by us, have become the standard over the stainless steel stents mainly due to easier placement, non-shortening and superelasticity ensuring better contact with the vessel wall even after deformation [15].

Despite the shortcomings, stent placement is an immediate, life-saving intervention with no viable alternatives for those affected by refractory lesions. Surgical venous reconstruction in the thoracic region is frequently impossible to perform in elderly hemodialysis patients. Ligation of the ipsilateral fistula to relieve the symptoms of CVD results in permanent abandonment of the extremity for dialysis. Therefore, it should be considered only when all other treatment modalities have been exhausted. There are some preliminary reports about possible benefits of using covered stents, drug-eluting or more biocompatible stents as well as brachytherapy to prolong vein patency [18–20]. All the options have some theoretical advantages, but further investigation is needed.

Conclusions

Our patient presented with a symptomatic central vein occlusion and was successfully treated accordingly to current recommendations with balloon angioplasty followed by a stent placement. The main objective was the salvage of a functioning arteriovenous fistula. The performed endovascular intervention is a safe and effective approach to correct CVD for a short term. To ensure long-lasting effects, the patient will require enhanced follow-up and inevitable reinterventions. For that matter, prevention of CVD remains critical. The "fistula first" approach combined with a great care in regard to indication, implantation and surveillance of dialysis catheters may be the key to counteracting morbidity and mortality in the dialysis population.

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