Haemothorax as a complication of subclavian vein cannulation with a haemodialysis catheter — a case report

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ABSTRACT

We present the case of a 39 year-old male patient admitted to ICU with symptoms of acute metabolic acidosis. He was investigated for the presence of methanol and glycol. Conservative treatment was initially started, followed by haemodialysis. During insertion of a temporary haemodialysis catheter in a location of Haapaniemi and Slatis, the patient was conscious but restless; therefore sedation was required to continue the procedure. After three hours of haemodialysis, the patient's general condition suddenly deteriorated. Hypovolemic shock and acute respiratory distress led to hypothesis of right haemothorax, which was rapidly confirmed by angio-CT examination. Trachea was intubated, drainage of right pleura was performed and aggressive fluid treatment begun. The patient was admitted to the operating theatre, and thoracotomy with reconstruction of damaged right venous angle was carried out. After the operation, the patient was transferred to ICU. He was mechanically ventilated and remained haemodynamically unstable. Although fluids and blood-made concentrates were transfused and catecholamines continuously administered, his clinical condition deteriorated and finally the patient died.

We found two independent causes of this fatality: hypovolemic shock and acute extrinsic metabolic acidosis. However, this paper focuses on the problem of the iatrogenic complication, which was haemothorax. In the literature there are described examples of such cases. Authors emphasise the most traumatic moment of cannulation as being insertion of the guidewire and dilator to perform a tunnel for the catheter. Puncture by needle and localisation of the central vein results in fewer complications. Furthermore, we strongly recommend monitoring patients after central veins cannulation. All sudden deteriorations in clinical condition should be followed by meticulous diagnosis for the presence of this life-threatening complication.

Key words: subclavian vein, cannulation; venous cannulation, complication; venous cannulation, haemothorax

Central venous cannulation is one of the basic procedures performed on intensive care unit patients. Renal substitutive therapy is the common indication for the insertion of central venous catheters for haemodialysis. Non-tunneled, temporary catheter implantation is the preferred method to obtain vascular access in patients requiring emergency haemodialysis. The total incidence rate of life-threatening complications that develop during central venous cannulation is estimated at 0.02–1.5% [1–4]. These complications include blood vessel perforation, heart wall perforation with a resultant cardiac tamponade, air embolism, pneumothorax, mediastinal and pleural haemorrhages, and ventricular arrhythmias, including ventricular fibrillation. The risk of such complications is substantially higher during the insertion of haemodialysis catheters due to the use of more rigid dilators and the thicker mucus membranes. This report presents the case of an iatrogenic perforation of the subclavian vein at its opening into the brachiocephalic vein, leading to a massive haemorrhage into the pleural cavity.

CASE REPORT

A 39-year-old patient was scheduled for haemodialysis therapy due to severe metabolic acidosis associated with methyl alcohol intoxication (acid-base balance parameters
on admission were pH 6.8, BE 29.8 mmol L\(^{-1}\), pCO\(_2\) 18 mm Hg, pO\(_2\) 65 mm Hg, a bicarbonate concentration of 3.4 mmol L\(^{-1}\), and a lactate concentration of 15.0 mmol L\(^{-1}\)). Additionally, the serum methanol level was 70 mg dL\(^{-1}\).

Using supraclavicular access, the venous vessels were identified under infiltration anaesthesia. A skin nick was made and the guidewire was inserted with the intent of puncturing the internal jugular vein and the subclavian vein junction at a venous angle (according to Haapaniemi and Slatis). Despite several attempts, however, the catheter placement failed, which was caused by marked psychomotor agitation from the patient. The procedure was successfully completed after the administration of shallow, intravenous general anaesthesia. A double-lumen, non-tunnelled, 15 cm long 12F dialysis catheter was introduced to initiate haemodialysis using the Seldinger technique (Fig. 1). The patient was immobilised during the procedure because of the significant psychomotor agitation, which, however, did not completely prevent the body movements and was associated with changes in the catheter location.

Approximately three hours after the onset of haemodialysis, the patient’s condition deteriorated and an anaesthesiological consultation was requested. Once the anaesthesiologist arrived, the patient was in shock, sweaty, pale and had clinical symptoms of respiratory failure. Following auscultation, a weak vesicular murmur was heard on the right side of the thorax. Thus, haemothorax was suspected. A vascular CT of the chest was performed, demonstrating a large haematoma in the right pleural cavity that was compressing the lung, causing atelectasis and the mediastinal to be shifted to the opposite side (Fig. 2). A drain was inserted into the right pleural cavity, which led to approximately 2,500 mL of blood outflow. The patient was prepped for surgery, and simultaneously, a vigorous therapy for haemorrhagic shock was initiated. Prior to the onset of surgery, another 2,000 mL of blood was evacuated from the pleural cavity. Following a transsternal thoracotomy, a haemodialysis catheter was localised into the upper mediastinum within the lumen of the superior vena cava. The brachiocephalic and the right internal jugular veins were then exposed, and a linear, approximately 1 cm long tear of the subclavian vein was observed in the anterior-superior fragment at the junction with the internal jugular vein. The tear was haemorrhaging an abundant amount of blood. Vascular clamps were placed on the subclavian and brachiocephalic veins, and local haemostasis was achieved, allowing for the dialysis catheter to be removed. The right subclavian vein was ligated and stitched together with the right brachiocephalic vein using a vascular suture. The right pleural cavity was opened and approximately 2,000 mL of clotted blood was evacuated; however, the origin of the pleural injury was not found. An additional drain was inserted into the pleural cavity and the thorax was closed without incident. The patient’s intraoperative condition was extremely severe as a result of the uncompensated haemorrhagic shock. To treat the shock, the patient received 14 units of red blood cells, 8 units of fresh frozen plasma, 12 units of platelets and 2,000 units of prothrombin factors. Moreover, infusions of noradrenaline and dopamine were required in incremental dosages of up to 1.0 μg/kg b.w.\(^{-1}\) min\(^{-1}\) and 20 μg/kg b.w.\(^{-1}\) min\(^{-1}\), respectively.

After surgery, the patient was transferred to the ICU. Once relative haemodynamic stability was achieved, the 12F haemodialysis catheter was re-introduced into the left subclavian vein and 2 hours of haemodialysis was performed. Unfortunately, the patient’s condition did not improve. For-

![Figure 1. Chest CT scan — location of the haemodialysis catheter, haemothorax](image1)

![Figure 2. Chest CT scan — haemothorax](image2)
ty-five minutes after the completion of the renal substitutive therapy, cardiac arrest occurred with a pulseless electrical activity, and the patient was pronounced dead.

DISCUSSION

Haemorrhage from an injured blood vessel is a rare and potentially fatal complication of a central venous cannulation. In cases of a massive haemorrhage in the pleural cavity, emergency thoracotomy to secure the bleeding vessel is known to be a life-saving procedure. Venous vessels are likely to be injured at any stage of a cannulation, most commonly during the formation of an intradermal nick with an expander, or during implantation of a catheter when insertion of the catheter guide is too shallow. The sharp end of expanders or catheters, unless inserted along the vessel axis, can perforate the vessel. Under unfavourable conditions during the same scenario, the pleural membrane is also likely to be damaged, resulting in haemorrhage into the pleural cavity. A vessel injury caused by an identification needle is much less probable. Even multiple punctures of venous or arterial vessels only sporadically lead to injury and bleeding. The vessel wall, however, can be lacerated by a sharp needle tip, particularly when the needle is not fixated along the vessel axis and is moved perpendicularly to the vessel wall. Traumatic vessel injuries by a bent guide tip are also quite unlikely.

Dialysis access can be achieved using non-tunnelled, sharp-ended temporary catheters or tunnelled, blunt-ended permanent catheters. The choice of the dialysis access method depends on the urgency of the indications and on the anticipated time of the catheter insertion procedure. In emergencies and during relatively quick haemodialyses, sharp-ended catheters are preferable because their insertions are less laborious and tunnulation is not required. In the remaining cases, the implantation of permanent, sleeved, tunnelled catheters is recommended. In intoxicated patients requiring emergency haemodialysis, the best solution is to implant temporary catheters. The preferable access point in these cases is via the right internal jugular vein, compared with a subclavian vein access, where incidental artery puncture is more common but the improper placement of the catheter is markedly less rare. Haemothorax, pneumothorax and vein lumen closure complication rates are comparable [4].

In this case, it was difficult to explicitly define the mechanism of the vessel injury. A short, non-tunnelled catheter was used. According to the experienced nephrologist performing the procedure, the identification of the central vein and the insertion of the guidewire were uneventful. The cannulation of the right subclavian vein was chosen for the supraclavicular catheter access (according to Haapaniemi and Slatis) with the aim of puncturing the junction of the internal jugular and subclavian veins (“venous angle”). The catheter was inserted into the subclavian vein just before its junction with the internal jugular vein, which was confirmed radiologically and intraoperatively (Fig. 1). The difficulties occurred when the insertion of catheter was attempted and were also associated with the lack of the patient’s cooperation. Specifically, the continuous and full control of the guide insertion depth was not possible because of the patient’s movements; therefore, the vessel wall could have been injured during the expander insertion and during the first failed attempt of catheter implantation. Once the patient was given anaesthesia, the optimal conditions were provided for the procedure, which allowed for the insertion of the dialysis catheter into the proper location. A catheter guide was previously introduced and continuously present in the vessel, thus allowing for the catheter to be inserted along the guide without further attempts to identify the venous vessel. Considering the patient’s movements, another mechanism of vessel perforation could have developed, such as an injury by the sharp end of the identification needle.

According to a study by Haapaniemi and Slatis, the inventors of the vascular access technique used in this case, the incidence rate of severe complications with this technique was approximately 1% based on 600 cannulation cases [3]. During the Haapaniemi and Slatis study, 2 pneumothorax and 4 haematoma cases occurred, but the locations of these were not given (injection site or the pleura). Moreover, the authors emphasised that the majority of these complications developed when the angle between the axis of the cannulated vein and the needle was acute and that the most traumatic stage of the procedure was associated with manipulations during the catheter introduction into the vein and not during its identification.

During a central venous cannulation, the patient’s cooperation is essential. Thus, the lack of cooperation in our case was the key cause of the complication. Cannulation in a calm patient, who is informed about the aim and course of the procedure, or in a patient under general anaesthesia, significantly improves the procedure conditions and markedly contributes to the proper placement of the catheter [5]. Attempting cannulation in uncooperative and agitated patients is very risky because it can lead to complications, including fatal ones. Observation of patients during central venous cannulations is extremely important for a patient's safety.

A sudden deterioration of the general condition of the patient following a central venous cannulation should arouse suspicions of complications [6]. Prompt diagnostic procedures, including a bedside ultrasound, transoesophageal echocardiography, or a vascular CT, as was done in the present case, and the implementation of quick and
suitable management procedures can save a patient’s life [5, 7]. The use of an ultrasound during central venous cannulation reduces the incidence of complications [8, 9]. The consequences of the presence of the dialysis catheter in the brachiocephalic vein when the subclavian vein is perforated are also worth emphasising. The constricted lumen of the brachiocephalic vein by the catheter hinders the outflow of the venous blood, which can intensify haemorrhage from the perforated subclavian vein and can similarly lead to increased pressure in the superior vena cava caused by the blood returning from the haemofilter. It should be noted that the catheter-injured vascular walls are, to some extent, protected by the catheter, and each attempt to remove it outside of the operating theatre without the supervision of a vascular surgeon can contribute to intensified bleeding and lead to death [8, 9]. Additionally, when a vascular wall puncture is suspected, the catheter lumen should not be filled with heparin.

The diagnosis of haemorrhage in dialysed patients due to severe non-consumptive alcohol intoxication is difficult. Such intoxications are usually accompanied by treatment-resistant hypotension, which likely masks the symptoms of haemorrhagic shock, and more so because intermittent haemodialysis often results in haemodynamic disturbances, particularly in hypovolaemic patients. Some additional symptoms of methyl alcohol intoxication, such as tachycardia, anuria, drenching sweats, and consciousness disturbances, are characteristics of haemorrhagic shock, which can also delay a haemorrhage diagnosis. In the present case, the reason for the anaesthesiological consultation was associated with symptoms of respiratory failure caused by extensive lung atelectasis, which was induced by a pleural haematoma compression and not by the symptoms of shock. The massive haemorrhage substantially worsened the already poor prognosis. The case presented provokes reflection. It confirms a well-known regularity that in medical procedure-associated complications, most heroic efforts and measures used to control complications are often disproportionate to the simple activities that can be performed to avoid them.

References:

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Received: 28.11.2012
Accepted: 11.03.2013