

Complications of subclavian Vein Catheterization and Their Management in the ICU

Leonidas Grigorakos^{1,2*}, Daria Lazarescu², Katerina Tzortzopoulou², Anastasia Alexopoulou², Maria Bikou², Dimitra Markopoulou², Agapi Chelmi², Ioannis Alamanos²

¹Faculty of Nursing, National and Kapodistrian University of Athens, Greece.

²Intensive Care, "KAT" Trauma Hospital of Athens, Kifissia, Greece.

Corresponding Author: Leonidas Grigorakos, Associate professor, 2 Nikis St, 14561, Kifissia, Athens, Greece, **Tel:** +30.210.3709522;

Email: grigorakos@parliament.gr

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ABSTRACT

The subclavian approach remains the most commonly used blind approach for subclavian vein catheterization (SVC). Its advantages include consistent landmarks, increased patient comfort, and lower potential for infection or arterial injury compared with other sites of access. However, the list associated with this procedure is quite long. Thus, we describe here the case of three patients in whom serious but preventable SVC complications occurred in an intensive care unit (ICU). We emphasize the role of proper management for minimizing the negative consequences associated with SVC.

KEY WORDS

Catheters and Catheterization; Complications; Veins; Access; Veins, Interventional Procedures.

ABBREVIATIONS

ICU – Intensive Care Unit

SVC – Subclavian Vein Catheterization

INTRODUCTION

Subclavian vein catheterization (SVC) is a technique used worldwide millions of times each year for the management of perioperative fluids or the administration of chemotherapy, total parenteral nutrition, or long-term antibiotics. This procedure is often a successful and uncomplicated. However, reported complication rates range from 0.3 to 12 %, according to the experience of the physician and the definition of complications [1]. Potential complications include failure to locate or cannulate the vein, puncture of the subclavian artery, misplacement of the catheter (placement of the catheter tip in the contralateral subclavian vein or in either jugular vein), pneumothorax, mediastinal hematoma, haemothorax, and injury to adjacent nerves [2]. Except for the physician's experience, the risk factors for complications and failures of subclavian-vein catheterization are poorly understood.

Here, we present our gained experience from more than one hundred SVCs performed in one month in our 14-bed ICU, reporting the case of complications that occurred during the attempts to cannulate the subclavian vein of three patients who were admitted to our intensive care unit (ICU) and we discuss the management of such complications.

CASE PRESENTATION

Case 1

A 52-year-old overweight patient was admitted in the ICU with acute respiratory failure, exacerbated by his chronic obstructive pulmonary disease. He was placed under mechanical ventilation and on the sixth day of his hospitalization a subclavian catheter was placed on the right side to measure central venous pressure. Chest X-rays after cannulation showed right pneumothorax and subcutaneous emphysema. The catheter

was removed, and thoracentesis was performed. The patient continuously improved his condition and was released from the ICU on the 15th day of his hospitalization.

Case 2

A 58-year-old underweight patient was admitted to the ICU with radiologically diagnosed pneumonia, acidosis and shock. The patient was placed on mechanical ventilation, and a catheter was placed in the right subclavian vein to measure the central venous pressure and for rapid fluid administration. Chest X-rays after cannulation showed right haemothorax. The catheter was removed, and another one was placed in the left subclavian vein. Thoracentesis was performed and yielded 200 ml of bloody fluid. This led to an important improvement in the patient's respiratory status and after 10 days and he was released from the ICU in good condition.

Case 3

A 52-year-old patient was admitted to the ICU with tetanus. He was placed under mechanical ventilation and the right subclavian vein was cannulated for central venous pressure measurement and fluid administration. Chest X-ray, after catheter placement, was normal. On the 9th day of hospitalization, the patient showed signs of septic shock. Because there was no obvious septic focus, repeated blood and urine cultures were performed. One of the blood cultures showed *Escherichia coli*. The catheter was removed, and its tip was sent for culture, which also showed *Escherichia coli*. The patient survived the septic shock and was transported on the 18th day of hospitalization to an artificial kidney unit due to renal insufficiency.

DISCUSSION

The subclavian approach remains the most commonly used blind approach for SVC. Its advantages include consistent landmarks, increased patient comfort, and lower potential for infection or arterial injury compared with other sites of access.

However, more than twenty different complications have been described and their rates range up to 15%, with mechanical complications reported in 5-19% of patients [3-5], thrombotic complications in 2-26% [6] and infectious complications in 5-26% [1,7]. Indeed, in a university hospital complications' rate reached 11,1% [8]. In our case, in more than one hundred SVCs performed in one month in our 14-bed ICU, we only encountered three complications.

The most common and frequent complications of SVC are pneumothorax, haemothorax, fusion of the sub-occipital artery and catheter entry into another vessel. These complications are all potentially life-threatening and, invariably, consume significant resources to treat. In our cases described

above, one patient had pneumothorax, one haemothorax and in one case the catheter was responsible for septic shock.

These complications might have been avoided if the physicians who performed the catheterization and the staff taking care of patients in critical condition had taken all the necessary catheter placement's measures. Indeed, an effective management of patients in need of SVC implies not only foreknowledge of the procedure and its complications before placing a central vein catheter but also house staff's substantial training and supervision. This is so because some risk factor of complications may be identified before the insertion of the catheter while others may be apparent only during catheterization.

Experience revealed that patients should be carefully selected for SVC. In this regard, *first*, it should be avoided in the case of overweight, or underweight patients as well as in the case of patients with emphysema.

Second, physicians' lack of experience is directly proportional to subclavian's complications. They should have an excellent knowledge of the anatomy of the area as the poor knowledge of the anatomical relationships of the subclavian with the clavicle is the most commonly known cause of the pneumothorax [9]. That is why doctors without experience should perform catheterization under the supervision of experienced colleagues. More so, physicians should either often place central catheters or not at all. It was recently reported that 46% of the complications arose in the case of doctors who placed only 1-2 central catheters during the year [8]. In our case, we believe that both pneumothorax and haemothorax were related to resident physicians' lack of experience.

Third, the aseptic technique of catheter placement and its management represent an axiom for the prevention of septic complications. Central vein catheters, urgently placed during resuscitation, should be removed as quickly as possible. In some studies, the occurrence of septic complications varies from 0-25% [10]. The occurrence of septic shock in one of our patients is believed to be related to the ignorance of the risks central venous catheterization involves, particularly the major dangers of inadequate day care, non-aseptic technique, and lack of nursing staff.

Fourth, all measures should be taken to prevent air embolism. The Trendelenburg position, needle and catheter seal of the syringe, the absence of air in infusion devices are prerequisites for avoiding this fatal complication [11, 12].

Fifth, the catheter should never be pulled through the needle because there is a risk that the catheter will be cut and may remain or move from the subclavian area to the upper concave or cardiac cavities. The existence of catheter segments in the subclavian area, upper cavity or in the cardiac cavities

requires immediate surgery with the corresponding incision [7]. Here, it should be stressed that for patients leaving the intensive care unit the central catheters should be removed because there is a risk that they try to pull the catheter while air embolism or breakage of the catheter and the presence of its part in the circulation may occur.

Sixth, good blood flow should always be checked before connecting the catheter to infusion devices. If the catheter is not in the vein, it may cause hydrothorax, mediastinal fluid collection and cardiac tamponade [13].

Seventh, bibliography reveals that catheters are folded or misplaced in 27,6% of cases. In that case, they should be removed immediately to avoid hydrothorax or ascites [14]. More so, the length of the catheter must be checked because, entering the heart cavity, it can cause fatal arrhythmias [15].

Eighth, chest X-ray is necessary after catheter placement to control its position, its tip, possible pneumothorax or haemothorax [16].

Finally, multiple attempts of catheter placement should be avoided as they increase the likelihood of a complication's occurrence.

To conclude, we believe that, although the complications of the SVC are very serious and burden patients' already critical condition, taking appropriate measures minimizes their appearance. At the same time subclavian vein remains an excellent venous pathway that contributes to better monitoring and treatment of patients in the ICU.

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