

Subclavian Artery Injury Secondary to Central Venous Catheter Insertion

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Abstract

Introduction: Involuntary catheterization of the subclavian artery during an attempt at central venous access is a well-known complication. Historically, these patients are managed with an open surgical approach and repaired under direct vision through an infraclavicular/or supraclavicular incision.

Depending on the situation and the exact location of the arterial lesion, a covered stent, vascular closure device, tract embolization, or gradual reduction of catheter size may be used trans arterial. The method of treatment will depend on a variety of factors.

As for an open approach, the location and anatomy of the subclavian artery pose challenges in surgical exposure, which often require sternotomy or clavicular resection for adequate exposure of vessel and adequate vascular control and perform a primary closure or failing that a Vaso-vessel anastomosis.

Objective: Presentation of a clinical case at the General Hospital of Ticomán, of the Ministry of Health of Mexico City, of an inadvertent lesion of the subclavian artery secondary to the placement of a Central Venous Catheter to all the surgical community

Results: Male patient of 32 years of age, with a history of chronic alcoholism since the age of 19, who goes to the emergency department presenting nausea accompanied by vomiting of gastrobiliary content on more than 10 occasions, as well as intolerance to the oral route, oppressive type abdominal pain of predominance in epigastrium with intensity 9/10, with irradiation towards right hypochondrium, vital signs within normal parameters to physical examination is found with paleness of integuments, with moderate dehydrating, localized abdominal pain in epigastrium and right hypochondrium, Murphy present, positive pancreatic points, being diagnosed with Moderately Severe Acute Pancreatitis of ethyl origin, adverse event is reported for multiple failed attempts in right subkey, as well as multiple failed attempts in left subclavian with metal guide entrapment so it is control x-ray in which metal guide screwing is observed at the level of the 2nd intercostal space, patient is sent to Vascular Surgery, where metal guide is removed and left subclavian central venous catheter is placed without complications, Radiographic control is taken observing Right hemothorax

of more than 50% so endopleural probe is placed with an expenditure of 1250cc to its placement of frank hematic appearance, with hemodynamic deterioration, so surgical treatment of urgency performing right anterolateral thoracotomy/Right Subclavian Vascular Examination/Right Subclavian Artery Primary Closure/Middle Sternotomy/Placement of Right Endopleural Probe in 5th Intercostal Space.

Discussion: The insertion of central venous catheters into the subclavian vein was first described by Aubaniac in 1952. Since then, millions of central venous catheters have been placed each year by medical and surgical specialists in the femoral, internal jugular, and subclavian veins. Involuntary catheterization of the subclavian artery during an attempt at central venous access is a well-known complication. Historically, these patients are managed with an open surgical approach and repair under direct vision through an infraclavicular and/or supraclavicular incision.

Inadvertent arterial puncture with a small-caliber needle is usually benign and occurs in about 5% of cases. The consequences can be much more severe if a large-caliber catheter is placed in the artery (> 7 French), and this is estimated to occur in 0.1 to 0.8% of cases. Accidental artery canalization has traditionally been treated with open surgery, using a supraclavicular and/or infraclavicular approach.

Complications described in the literature by the placement of a central venous catheter include arteriovenous fistulas, pseudoaneurysms, hemothorax, and pneumothorax. A recent case series and a review by Guilbert., *et al.* showed that immediate removal of the blind catheter from the artery with external compression resulted in a higher complication rate of 47% and a mortality rate of 12%.

Conclusion: Failed insertion attempts are the strongest predictor of complications. Complication rates from failed insertion attempts for a CVC are higher for access through the subclavian vein compared to the internal jugular vein. There are several therapeutic options to successfully manage iatrogenic lesions of the subclavian either through an open approach or endovascular management.

Keywords: Injury; Artery; Subclavian; Central Venous Catheter; Hemothorax

Introduction

Involuntary catheterization of the subclavian artery during an attempt at central venous access is a well-known complication. Historically, these patients are managed with an open surgical approach and repair under direct vision through an infraclavicular and/or supraclavicular incision.

Inadvertent arterial puncture with a small-caliber needle is usually benign and occurs in about 5% of cases. The consequences can be much more severe if a large catheter is placed in the artery (> 7 French), and it is estimated that this occurs between 0.1 and 0.8% of cases. Accidental artery channeling has traditionally been treated with open surgery.

Complications described in the literature from central venous catheter placement include arteriovenous fistulae, pseudoaneurysms, hemothorax, and pneumothorax. A recent case series and a review by Guilbert., *et al.* showed that immediate blind catheter removal from the external compression artery resulted in a major complication rate of 47% and a mortality rate of 12%. Failed insertion attempts are the strongest predictor of complications. Complication rates from failed insertion attempts for a Central Venous Catheter through the Internal Jugular Vein have been reported in 12% of cases and between 12% and 20% for the Subclavian vein. Among patients who fail in

catheterization attempts, complications develop in 28%. Femoral catheterization has a higher incidence of mechanical complications than access by Subclavian Vein or Internal Jugular Vein.

Depending on the situation and the exact location of the arterial lesion, a covered stent, vascular closure device, tract embolization, or gradual reduction of catheter size may be used transarterial. The method of treatment will depend on a variety of factors.

As for an open approach, the location and anatomy of the subclavian artery pose challenges in surgical exposure, which often require sternotomy or clavicular resection for adequate exposure of the vessel and adequate vascular control and perform a primary closure or failing that a Vaso-vessel anastomosis.

Objective

Presentation of a clinical case at the General Hospital of Ticomán, of the Ministry of Health of Mexico City, of an inadvertent lesion of the subclavian artery secondary to the placement of a Central Venous Catheter to all the surgical community.

Case Report

This is a 32-year-old male patient, with a history of smoking since the age of 28 at the rate of 4 cigarettes a day, positive alcoholism from the age of 19 occasionally until reaching drunkenness, and occasional marijuana use. Starting his condition on 07/06/21 presented nausea accompanied by vomiting of gastrobiliary content on more than 10 occasions, as well as intolerance to the oral route, A day later adds abdominal pain type oppressive of predominance in the epigastrium with intensity 9/10, with irradiation towards right hypochondrium, so go to the emergency department with the following Vital signs: TA 119/73 mmHg, HR 88 bpm, FR 22 rpm, Temperature 36°C, on physical examination is found with paleness of integuments, with moderate dehydration, abdominal pain located in the epigastrium and right hypochondrium, Murphy present, positive pancreatic points, rest unchanged. Paraclinical studies include amylase of 678 U/L, Lipase 2163 U/L, GGT 508 IU/L, AST 81 IU/L, ALT 86 IU/L, Cr 2.44 mg/dl, BT 1.3 mg/dl, BD 0.1 mg/dl, BI 0.3 mg/dl, Na 139 meq/L, K 5 meq/L, CL 98 meq/L, Ca 8.7 meq/L, Leukocytes 18 x103, Neutrophils 87%, Hemoglobin 19.5 gr/dl, Hematocrit 56.6%, Platelets 223 x103, Arterial Blood Gas reports a pH 7.32, PCO2 28 mmHg, PO2 129 mmHg, Lactate 1.8 mmol/L, HCO3 4.6 mmol/L, BE -21.6 mmol/L, liver and bile duct USG is performed which reports Gallbladder 83x23x32 mm, wall 2 mm thick, homogeneous content, Common bile duct 4 mm, 10 mm holder. In the Chest X-ray, soft or bone tissues are observed without alterations, without radio-opacity, free cost diaphragmatic and cardio phrenic angles. Therefore, a diagnosis of Moderately Severe Acute Pancreatitis of Alcoholic origin is established.

Subsequently, an adverse event is reported for multiple failed attempts in the right subclavian, as well as multiple failed attempts in the left subclavian with metal guide entrapment by what is taken control x-ray (Figure 1) in which screwing of metal guide is observed at the level of the 2nd intercostal space, so the patient is sent to Vascular Surgery, where performs an approach by means of a right femoral access, where metal guidance is extracted and left subclavian central venous catheter is placed without complications, subsequently takes new control x-ray evidencing right hemothorax of more than 50% so endopleural probe is placed with expenditure of 1250 cc to its placement of frank blood aspect, with deterioration hemodynamic requiring vasopressor support, so emergency surgical treatment is performed, where right anterolateral thoracotomy/Vascular Exploration is performed Right Subclavian/Primary Artery Closure Right Subclavian/Middle Sternotomy/Right Endopleural Probe Placement in 5th Intercostal Space, having as findings: 500 cc hemothorax/2 mm Subclavian Artery Lesion at the upper edge, adjacent to the lower edge of the right clavicle.



Figure 1: Coiling of CVC metal guide is observed at the level of 2nd left intercostal space.

Subsequently, the patient is admitted to the Intensive Care Unit, intubated and with hemodynamic instability data with BP of 89/44 mmHg, TAM 59, FC 156 bpm, Saturation 88%, with FiO₂ 100%, administering crystalloid solutions, 4 are transfused erythrocyte concentrates and 2 fresh frozen plasmas, aminergic support is maintained until perfusorial blood pressures are achieved, control laboratories are taken in which leukocytes are observed: Leukocytes of 5.1, Neutrophils 3.6, Hemoglobin 9.3 gr/dl, Hematocrit 26.5%, Platelets 23000, BT 1.5, Na 133, K 4.2, Cl 108, Cr 0.85, proceeding with adequate clinical and post-surgical evolution so we proceed to retract treatment aminergic and extubate the patient 3 days later, with little expenditure through the endopleural probe with serohematic expenditure so it is decided to withdraw from it, maintaining saturations above 90% with adequate clinical evolution, so the patient's discharge and follow-up through the outpatient consultation is decided.

Discussion

The insertion of central venous catheters into the subclavian vein was first described by Aubaniac in 1952. Since then, millions of central venous catheters (CVCs) have been placed each year by medical and surgical specialists in the femoral, internal jugular, and subclavian veins [1]. Involuntary catheterization of the subclavian artery during an attempt at central venous access is a well-known complication. Historically, these patients are managed with an open surgical approach and repair under direct vision through an infraclavicular and/or supraclavicular incision [2].

These catheters are often of large caliber and are critical in the treatment of many patients who require adequate hemodynamic control, hemodialysis, parenteral nutrition, or multidrug therapy. aminergic.

Inadvertent arterial puncture with a small caliber needle is usually benign and occurs in about 5% of cases [3]. The consequences can be much more severe if a large-caliber catheter is placed in the artery (> 7 French), and this is estimated to occur in between 0.1 and 0.8% of cases [4]. Accidental canalization of the artery has traditionally been treated with open surgery, using a supraclavicular and/or infraclavicular approach.

The complications described in the literature by the placement of a central venous catheter include arteriovenous fistulas, pseudoaneurysms, hemothorax, and pneumothorax. A recent case series and a review by Guilbert., *et al.* [5] demonstrated that immediate removal of the blind catheter from the artery with external compression resulted in a rate of complications greater than 47% and a mortality of 12%.

Carotid artery injury during attempts at internal jugular vein (IJV) catheterization occurs with a frequency of 6 - 10%. Puncture of the subclavian artery is even less frequent, occurring in 0.5 - 4% of patients. Spinal artery injuries are the rarest complications of CVC insertions. These perforations rarely have serious consequences and are most often resolved with manual pressure [6].

The incidence of mechanical complications is modified by a variety of factors among which are mentioned

1. Inexperience on the part of the staff who are going to place a CVC, which represents a higher rate of complications.
2. Number of attempts at the placement of a CVC, increasing the incidence of complications with two venopunctures to an increase of up to six times with three or more attempts [7,8].
3. Body mass index (BMI) > 30 or < 20, previous catheterizations, severe dehydration, and hypovolemia are factors that increase the risk [9,10].
4. Coagulopathies do not appear to increase the risk of insertion of a CVC if appropriate precautions are taken such as transfusing platelets into thrombocytopenic patients until a count of at least 50,000 or more, and fresh frozen plasma (FFP) in patients with elevated prothrombin and partial thromboplastin times [11-13]. Even heparinization does not appear to increase the risk of bleeding or hematoma during the insertion of a CVC through the VVI [14]. Although coagulopathies are not a clear contraindication VVI, or femoral vein (VF) appears to be the compressible site of choice chosen by many authors for patients with bleeding disorders [15-17].

Failed insertion attempts are the strongest predictor of complications. Complication rates from failed insertion attempts for CVC through VVI have been reported in 12% of cases, [18] and between 12% and 20% for Subclavian Vein (VSC) [19]. Among patients who fail in catheterization attempts, complications develop in 28% [8]. Femoral catheterization has a higher incidence of mechanical complications than access by VSC or VVI [20].

The puncture and/or arterial perforation during the insertion of the CVC on the VSC has a higher incidence on the right side, this is due to the anatomical differences of the vascular system on both sides of the midline [21,22]. On the right, the subclavian-jugular venous junction overlaps the subclavian artery, making this vessel more prone to injury than on the opposite side. Right VSC enters the coxal bone at a sharper angle compared to the one on the left side, which would make it more vulnerable to perforation if inserted too much deeper into a firm dilator [21].

Imaging plays a critical role in the evaluation of vascular lesions related to CVC placement. High-resolution computed tomography angiography allows us to define vascular anatomy as well as injury to allow treatment planning. Catheter angiography is primarily used during the treatment process to demonstrate effective exclusion of vascular injury.

A variety of applications of various devices, such as stents, closure devices, and balloon tamponade, have been described to treat complications related to unintentional injuries of the subclavian artery that arise during CVC placement [22-25].

Depending on the situation and the exact location of the arterial lesion, a covered stent, vascular closure device, tract embolization, or gradual reduction of catheter size may be used. trans arterial. The method of treatment will depend on a variety of factors [26].

The use of a covered stent is especially used in cases where the subclavian artery is dissected, there is a pseudoaneurysm, or there is persistent bleeding from the site of injury. The advantage of an expandable balloon stent is that it has a very controlled deployment and is of flexible size since the stent can be further expanded with the use of larger balloons for the treatment of subclavian lesions that are not well documented.

The long-term results of stents covered for the treatment of subclavian lesions are not well documented. In addition, if the site of arterial injury is at the thoracic in/out, there is a risk of collapse and/or fracture of the Como stent resulting from extrinsic compression. In addition, the use of a stent is not always possible due to the proximity of the lesion of the subclavian artery to the origin of critical vascular branches, such as the vertebral artery.

In general, it is important to recognize when an arterial lesion has occurred secondary to the placement of a CVC and the severity of a complication. Proper manual compression of the subclavian artery to obtain hemostasis is often not possible due to the interposition of subcutaneous tissue and bone structure, as well as a lack of structural support around the subclavian artery [27].

Involuntary catheterization of the subclavian artery during CVC placement can be treated with endovascular techniques.

Arterial closure devices may be attempted, especially when the distance between the skin and the path of the artery is less than 5 cm and access to the artery is still available. Embolization of the tract with Gelfoam can be used. Angiographic and clinical follow-up is recommended during any of these treatment methods so that, if they fail, control of the injured artery can be maintained until it can be devised. an alternative treatment option [27].

The current literature favors primary endovascular repair (such as stent placement) of traumatic subclavian artery injuries in hemodynamically stable patients. Endovascular approaches have the advantage of being less invasive than open surgery, they are associated with less intraoperative blood loss, an improvement in mortality, and a shorter hospital stay [28].

As for an open approach, the location and anatomy of the subclavian artery pose challenges in surgical exposure, which often require sternotomy or clavicular resection for adequate exposure of vessel and adequate vascular control and perform a primary closure or failing that a vaso-vessel anastomosis.

Conclusion

Failed insertion attempts are the strongest predictor of complications. Complication rates from failed insertion attempts for a CVC are higher for access through the subclavian vein compared to the internal jugular vein. Because the rate of complications decreases with training, designing a CVC insertion method is logical to promote prevention and decrease the incidence of adverse events. Standardization can also establish Manejo guidelines for some complications that commonly follow CVC insertion.

In conclusion, there are several therapeutic options to successfully manage iatrogenic lesions of the subclavian either through an open approach or endovascular management, however, treatments endovascular be of less invasion, have a lower rate of morbidity and mortality and reduce the time of stay in hospital have become the management of choice in this type of patients.

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