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CASE REPORT

Management of arterial trauma during central venous catheter insertion using a percutaneous suture-mediated closure device (Perclose ProGlide): a report of two cases and literature review

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Abstract

We evaluated the safest approach to treat catheter-related cervicothoracic arterial injuries by reviewing two inadvertent arterial injury cases during central venous catheter insertion and their related complications at an intensive care unit. In the first case, C-arm angiography confirmed accidental catheter placement in the right subclavian artery (SCA). In the second case, accidental catheter placement in the right common carotid artery was confirmed *via* computed tomography angiography of the neck and chest. The catheter was connected to a high-pressure arterial bag in both cases. The Perclose ProGlide Suture-Mediated Closure System (Abbott Laboratories, IL, USA) was used and successfully operated the two cases of iatrogenic SCA and carotid artery injuries. A follow-up bedside ultrasound at 2 and 6 hours postoperatively revealed normal Doppler waveforms in the inadvertent arterial injury and distal arteries without hematoma at the puncture site in both cases. In conclusion, for inadvertent artery puncture, which occurs in $<$12% of jugular and subclavian venous procedures, the endovascular approach using a covered stent appears to be safe for treating the accidental catheter placement in the carotid artery, although some cases of post-procedure stroke have been reported. In this regard, the percutaneous arterial suture device (Perclose ProGlide) offers an almost 100% success rate and lowers morbidity and mortality rates compared with open surgical and endovascular approaches for treating iatrogenic SCA and carotid artery injuries. These two cases highlight the effectiveness of minimally invasive percutaneous arterial closure devices in treating this infrequent but potentially lethal injury.

Keywords

Inadvertent puncture; Central venous catheter; Percutaneous arterial closure device

1. Introduction

Central venous catheterization is routinely performed in intensive care units and intraoperatively in some indicated cases by anesthesiologists. This procedure involves catheter insertion through the internal jugular vein (IJV) or the subclavian vein. Real-time ultrasound guidance is commonly used to improve the safety of this procedure. However, this procedure is also blindly performed at patients' bedside. Despite significant advances in ultrasound-guided catheterization, the estimated incidence rate of inadvertent artery puncture remains 2.5%–4.5%, among whom 0.1%–0.5% receive large-bore catheter cannulation [1, 2]. Given the anatomical artery position, manual compression is often inefficient for achieving hemostasis [3]. Thus, the invasiveness of the procedure and significant blood loss during open surgery are the main disadvantages of this approach. Unfortunately, as an alternative to open surgery, endovascular use of covered stent grafts in the subclavian artery (SCA) and carotid artery carries the risk of vertebral artery occlusion and post-procedure stroke and death, respectively [4, 5]. Recently, percutaneous arterial closure devices have been used to treat injured vessels. Thus, in this case report, we aimed to determine the safest approach to treat catheter-related cervicothoracic arterial injuries by reviewing our experience using the Perclose ProGlide Suture-Mediated Closure System (Abbott Laboratories, IL, USA).

2. Case presentation

2.1 Case 1

A 52-year-old male patient who underwent cytoreductive surgery and hyperthermic intraperitoneal chemotherapy for recurrent colon cancer with peritoneal metastases was transferred to the intensive care unit (ICU) for postoperative

management. His vital signs were: blood pressure, 110/57 mmHg; heart rate, 81 beats per minute; respiratory rate, 19 breaths per minute; and temperature, 36.6 °C. Laboratory tests revealed: hemoglobin level, 7.8 mg/dL; leukocyte count, 16.4 × 109/L; hematocrit, 28.2%; platelet count, 92 × 109/L; and international normalized ratio, 1.1. During his ICU stay, a 7-Fr triple lumen central venous catheter was placed through his right subclavian vein under ultrasound guidance by a senior ICU trainee resident. A percutaneous entry point was identified on sonography, but a high backflow of blood was also observed from the central venous catheter. In addition, the ICU resident noted an arterial catheter tracing, which was further confirmed *via* blood gas analysis. However, the catheter was connected to a high-pressure arterial bag, and an official referral was performed at our vascular and endovascular surgery section for access site management. A bedside ultrasonography color Doppler of the neck was performed, which confirmed an accidental catheter placement in the right SCA. The patient was brought to the operating room, where he was injected with contrast through the central line catheter, and C-arm angiography confirmed that the catheter placement was positioned in the right SCA (Fig. 1). The puncture site was >1.0 cm away from the vertebral artery origin. No thrombus was observed around the catheter, and the antegrade flow was normal, with no filling defects in the distal arteries. We did not detect any sign of contrast extravasation, arteriovenous fistula or pseudoaneurysm at the puncture site. The Perclose ProGlide Suture-Mediated Closure System (Abbott Laboratories, Illinois, USA) (Fig. 2) is generally used for closing common femoral artery puncture sites. According to the manufacturer's instructions, this device should not be used for puncture sites close to the origin of a major branch or should not be located <1.0 cm from the bifurcation of vessels because it could cause an intimal dissection, acute vessel closure or pseudoaneurysm.

A 0.035″ angled Terumo stiff wire (Terumo Medical Corporation, Somerset, NJ, USA) was passed through the central venous catheter and placed across the descending aorta. Then, the central venous catheter was retrieved over the wire, and a 6-Fr percutaneous suture closing device, the Perclose ProGlide Suture-Mediated Closure System (Abbott Laboratories, IL, USA), was inserted over the Terumo wire. The suture was deployed with the wire in place, and the knot was tightened using a knot pusher. The suture was cut after confirming the absence of an aneurysm or contrast extravasation at the arteriotomy site. Bedside ultrasound at 2 and 6 hours post-procedure revealed normal Doppler waveforms in the subclavian and distal arteries without hematoma at the puncture site. The patient had an uneventful postoperative recovery, and a follow-up postoperative computed tomography (CT) scan of the chest revealed no stenosis or filling defect in the right SCA (Fig. 3).

2.2 Case 2

A 78-year-old woman presented to the emergency department due to a 2-day history of abdominal pain and perineal wound discharge. The surgical history included significant low-grade mucinous adenocarcinoma of the anal canal and abdominal perineal resection 2 months before this presentation. The patient was admitted for further investigation. During her hospital stay, she developed a non-ST elevation myocardial infarction with a very low Glasgow Coma Scale, hypotension and seizures, thereby requiring intubation and mechanical ventilation. The patient vital signs revealed a blood pressure of 74/46 mmHg, a heart rate of 123 beats per minute, a respiratory rate of 24 breaths per minute, and a temperature of 36.3 °C. She was transferred to the ICU for further management. Her laboratory tests revealed: hemoglobin level, 9.7 mg/dL; leukocyte count, 10.9 × 109/L; hematocrit, 32.7%; platelet count, 253 × 109/L; and international normalized ratio, 1.0. During her ICU stay, a 7-Fr triple lumen central venous catheter was placed through her right IJV under ultrasound guidance by a senior ICU trainee resident. A percutaneous entry point was identified on sonography, but a high backflow of blood was observed from the central venous catheter. In addition, the ICU resident noted an arterial catheter tracing, which was further confirmed *via* blood gas analysis. However, the catheter was connected to a high-pressure arterial bag. CT scan of the chest on axial view revealed a CCA (common carotid artery) central line coursing through the ascending aorta (arrowheads) and its incompletely fistulized tip. (Fig. 4A,B). Subsequently, she was referred to our vascular and endovascular surgery section for further management. In the operating room, injection of the contrast medium through the central line catheter and C-arm angiography was performed to confirm the position of the central line in the right CCA. No thrombus was observed around the catheter, and the antegrade flow was normal, with no filling defect in the distal arteries. Moreover, no contrast extravasation, arteriovenous fistula or pseudoaneurysm was observed at the puncture site. The Perclose ProGlide Suture-Mediated Closure System (Abbott Laboratories, Illinois, USA) (Fig. 2) was used for closing the femoral artery puncture sites. The instruction manual states that this device should not be used if the puncture site is close to the origin of a major branch or located <1.0 cm close to the bifurcation of vessels, which may result in an intimal dissection, acute vessel closure or pseudoaneurysm.

A 0.035″ angled Terumo stiff wire (Terumo Medical Corporation, Somerset, NJ, USA) was inserted through the central venous catheter and placed across the descending aorta. Then, the central venous catheter was retrieved over the wire. A 6-Fr percutaneous suture closing device, the Perclose ProGlide Suture-Mediated Closure System (Abbott Laboratories, IL, USA), was inserted over the Terumo wire. The suture was deployed with the wire, and the knot was tightened using a knot pusher. The suture was cut after confirming the absence of aneurysms and contrast extravasation at the arteriotomy site. She had an uneventful postoperative recovery and was transferred back to the ICU for further management. Moreover, bedside ultrasound at 2 and 6 hours post-procedure revealed normal Doppler waveforms in the right CCA and distal arteries without hematoma at the puncture site. A follow-up postoperative CT scan of the chest revealed no stenosis or filling defect in the right CCA (Fig. 5).

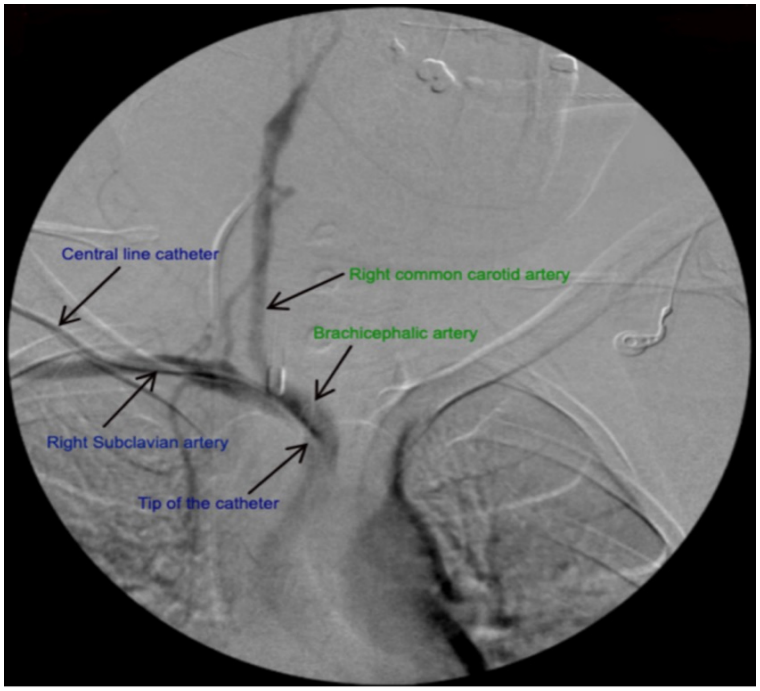

FIGURE 1. C-arm angiography confirmed the puncture and presence of a central line catheter in the right SCA.

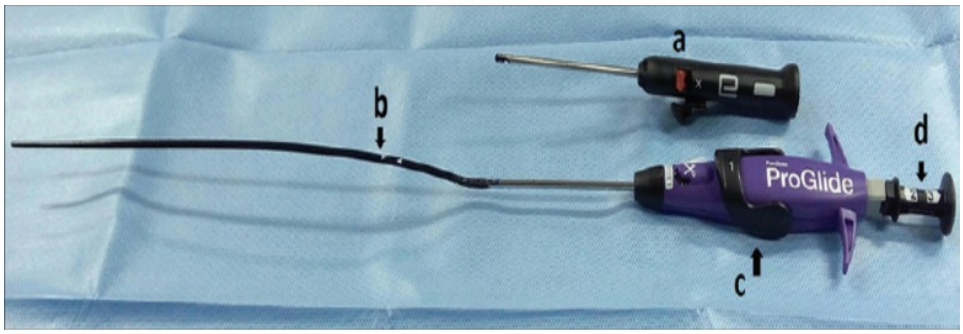

FIGURE 2. The Perclose ProGlide suture device used in this study. (a) knot pusher/trimmer, (b) sheath, (c) handle, (d) plunger.

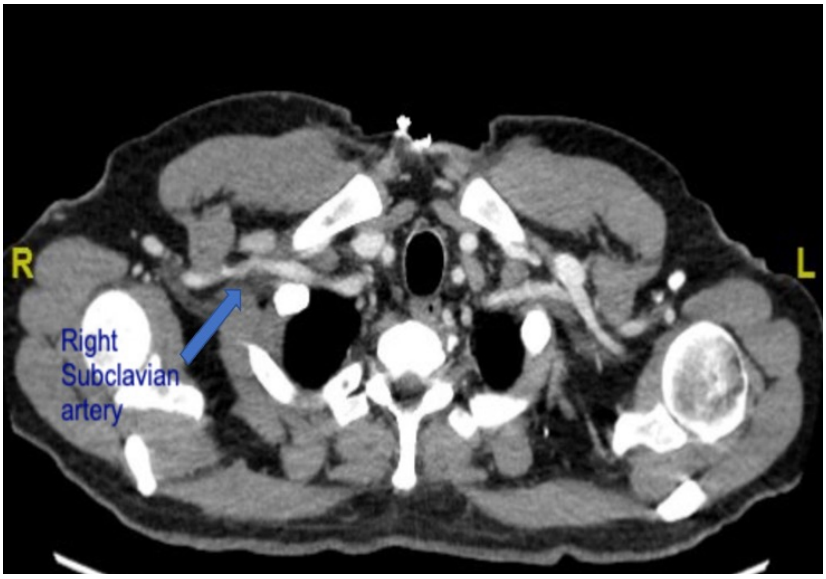

FIGURE 3. Postoperative computed tomography scan of the chest revealed no stenosis or filling defect in the right SCA (blue arrow).

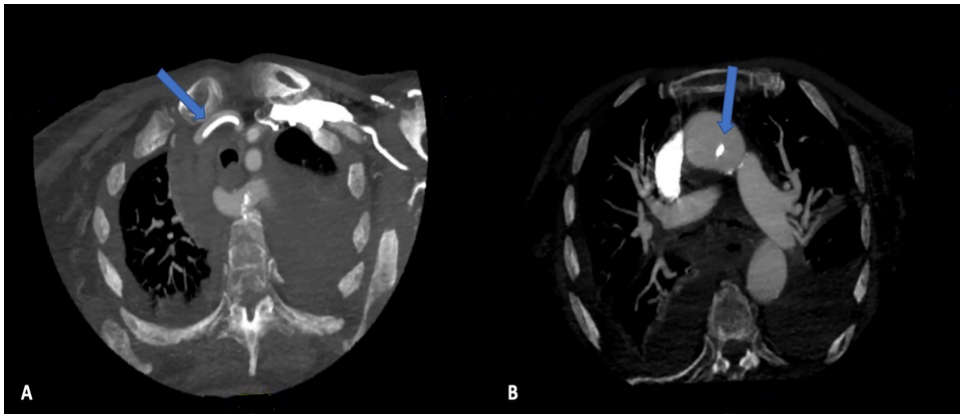

FIGURE 4. Pre-operative Computed tomography of the chest on axial view showing. (A) the right common carotid artery (CCA) central line coursing through the ascending aorta (arrowhead). (B) Right CCA central line and its incompletely fistulized tip (arrowhead).

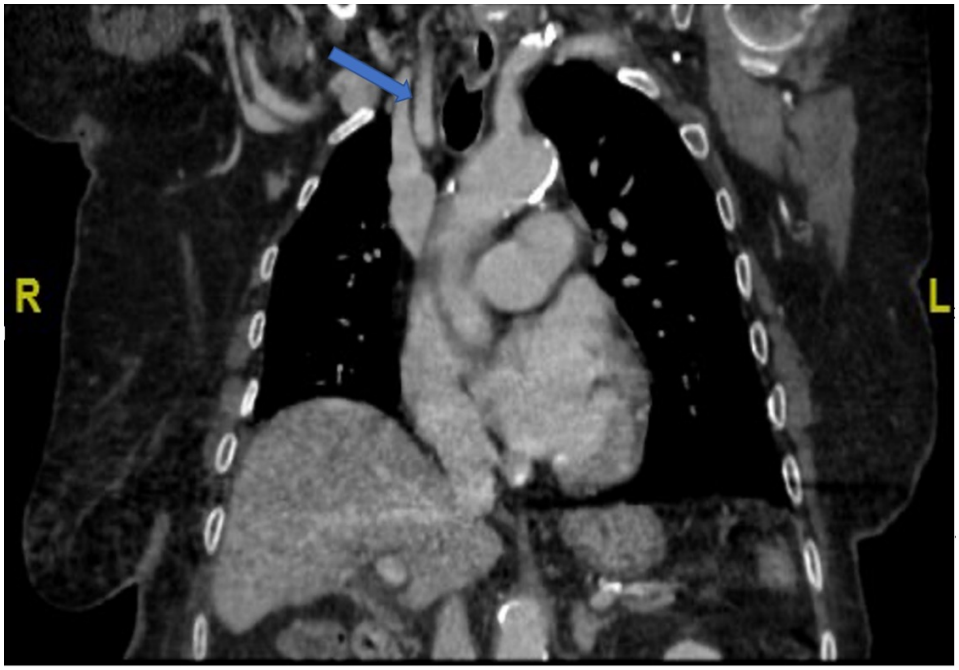

FIGURE 5. Postoperative computed tomography scan of the chest on coronal view showing the absence of stenosis or filling defect in the right common carotid artery (CCA) (arrowhead).

3. Discussion

The mechanical complications of central venous catheter insertion, including pneumothorax, air embolism, misplacement and bleeding, are quite frequent in clinical practice. Among them, arterial injuries are the most devastating complications because they could cause catastrophic morbidity and mortality unless promptly and effectively treated.

The incidence of arterial needle puncture during central venous catheter insertion ranges from 3.7% to 12% [6, 7] and is often routinely recognized and treated with compression. However, serious arterial injury involving the dilator or catheter is reported in 0.1%–1.0% of attempted central venous catheter insertions [8]. Wide-ranging complications include hematoma and excessive bleeding, arteriovenous fistula, hemothorax, pseudoaneurysm and thrombus formation, which could cause stroke, respiratory failure and death [9–12]. Real-time ultrasound guidance is commonly employed to improve the safety of this procedure, and non-radiologists should undergo ultrasound training courses before performing this procedure at patients' bedside to avoid such complications.

A common treatment approach that generally seems insignificant is to remove a small 22-gauge or 25-gauge "exploring" needle from the carotid artery and apply external pressure to prevent hemorrhagic complications [13–15]. Major complications related to needles in the aorta or carotid arteries have been reported [16–18], and in these cases, external compression for 3 to 15 minutes was performed to treat carotid puncture with a 20- or 21-gauge needle that occurred under general anesthesia. These patients had extensive carotid atherosclerotic plaque and presented with embolic stroke in the first 48 hours following the operation.

Once identified, the management of more severe catheter-related cervicothoracic arterial injury relies on several factors,

including the injury site, patient stability, catheter diameter, placement of the catheter and the patient's neurological conditions. Additionally, underlying arterial trauma must be recognized early and managed appropriately.

One must be aware that the low internal jugular vein approach can injure the aorta, subclavian, innominate vessels or carotid artery. Although the major arteries and the target veins are parallel, many arterial injuries may occur far from the targeted access vein, making it difficult to apply adequate external pressure to effectively stop the bleeding from the arterial puncture.

Prolonged arterial cannulation should not be tolerated due to the potential risk of developing a thrombus at the site of the arterial damage, particularly during prolonged catheterization. Thus, if immediate treatment is not feasible, heparinization should be considered.

Inadvertent arterial cannulation during central venous catheterization can be treated *via* the following two approaches: removal of the cannula and application of external pressure, or immediate surgical or endovascular treatment. Compared with endovascular approaches, open surgery is more invasive, with higher morbidity and less effectiveness for treating SCA injury because of the challenge of exposing the operated region. The SCA is found deep within the soft tissues behind the clavicle in a non-compressible location, causing harder-to-establish hemostasis and increasing the risk of hematoma or pseudoaneurysm. Open surgery, such as sternotomy or thoracotomy, can be employed to treat accidental SCA punctures, although it has high morbidity and mortality rates [19]. Endovascular stent-graft placement from an ipsilateral axillary or femoral artery is another option for treating accidental SCA punctures. However, it comes with a high risk of vertebral artery occlusion, stent thrombosis, stent stenosis, and thromboembolic events [4]. In this regard, numerous reports have described the successful application of percutaneous closure using the Perclose ProGlide closure device for an inadvertent SCA puncture during central line insertion [7, 20–22].

In the carotid artery, complications are more likely to occur in patients with large catheters. Some reports recommend the surgical removal of all catheters equivalent or greater than 7F due to the risks of potentially significant complications after manual compression. Moreover, devastating consequences could arise from the inadvertent insertion of the sheath in the carotid artery, particularly if the sheath is removed and manual compression is applied. Therefore, surgical repair is preferred for 7F or larger catheters [9]. The endovascular approach using covered stents appears safe for managing carotid artery injuries. However, there is reported case of post-procedure stroke and death after inserting an endovascular-covered stent in the carotid artery [5].

In a study by Bechara *et al.* [23], the authors reported the observations of 12 patients who underwent intraoperative carotid artery introducer sheath insertion while attempting to cannulate the jugular vein. Among them, six received immediate exploration of the carotid artery, sheath removal, and primary repair. The remaining six underwent percutaneous closure using a suture-mediated closure device. All patients were successfully treated, and the follow-up carotid duplex revealed no injury to the repaired artery. Therefore, percutaneous closure using the Perclose ProGlide closure device of an inadvertent carotid artery puncture during central line insertion could be a promisingly safe and less invasive procedure.

However, removal and compression should not be attempted because of the high risk of complications with dilator or catheter arterial injury. Although the exact device diameter is not reported in the literature, larger catheters could lead to higher complication risks in case of accidental artery puncture [9].

Percutaneous arterial closure devices commonly used to close common femoral artery puncture sites represent a straightforward and safe alternative. Various devices, such as Perclose ProGlide and Angioseal, have been used in similar cases described in the literature. The Perclose ProGlide closure device is indicated for the percutaneous delivery of sutures for closing the common femoral artery and vein access site in patients who have had diagnostic or interventional catheterization procedures. For the two reported patients in this study, the accidental SCA and CCA punctures were successfully closed using the Perclose ProGlide closure device, which helped avoid open surgery and the associated high morbidity and mortality rates.

Bleeding, infection, pseudoaneurysm and arteriovenous fistula formation are the most prevalent complications of these devices. Meanwhile, the use of the percutaneous arterial suture device (Perclose ProGlide) approach has a late complication rate of $<2\%$ and a success rate of nearly 100% for repairing femoral artery puncture sites [24]. Pikwer *et al.* [25] found that this approach could be limited in cases with obesity and angulation. In such situations, the Perclose ProGlide closure device should be inserted at a 45° angle to the femoral artery puncture site. In our cases, the Perclose ProGlide closure device was placed over a wire in real-time under fluoroscopy monitoring to eliminate kinks and angulations.

4. Conclusions

Inadvertent artery punctures can be avoided when catheter placement is performed under real-time ultrasound guidance. However, in case of injury, percutaneous arterial closure devices can be used to treat the injured vessels. In this regard, the Perclose ProGlide closure approach offers an almost 100% success rate, with lower morbidity and mortality rates compared to open surgical and endovascular approaches for treating iatrogenic SCA and carotid artery injuries. However, there are currently no standard guidelines for treating catheter-related cervicothoracic arterial injuries, urging the need for more studies on devices such as Perclose ProGlide to confirm their clinical efficacies and improve the therapeutic outcomes of such cases.

ABBREVIATIONS

IJV: Internal jugular vein; SCA: Subclavian artery; CCA: Common carotid artery; CT: Computed tomography; ICU: Intensive care unit.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

SA, KI—Study concept or design; SA, MYA, RN, NSA and KI—Data collection; Data interpretation; Literature review; Editing of the paper; SA, MYA and KI—Drafting of the paper.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Our work does not infringe on any rights of others, including privacy rights and intellectual property rights. There was no human rights violation in this study. The patient provided written informed consent for the publication of this case report. Ethical approval is exempt at our institution (College of Medicine, King Saud Medical City, King Saud University) for the case reports. Written informed consent was obtained from the patient to publish this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Lorenzo JF, Rey JV, Arquillo IL, Encisa de Sá JM. Off-label use of Proglide percutaneous closure device in iatrogenic arterial catheterizations: our experience. Vascular. 2020; 28: 756–759.

[2] Ezaru CS, Mangione MP, Oravitz TM, Ibinson JW, Bjerke RJ. Eliminating arterial injury during central venous catheterization using manometry. Anesthesia & Analgesia. 2009; 109: 130–134.

[3] Park TK, Yang JH, Choi S. Endovascular repair using suture-mediated closure devices and balloon tamponade following inadvertent subclavian artery catheterization with large-caliber hemodialysis catheter. Korean Circulation Journal. 2016; 46: 584.

[4] du Toit DF, Lambrechts AV, Stark H, Warren BL. Long-term results of stent graft treatment of subclavian artery injuries: management of choice for stable patients? Journal of Vascular Surgery. 2008; 47: 739–743.

[5] Gabrielli R, Rosati MS, Cristofani D, Vitale S, Siani A. Inadvertent carotid artery cannulation by dialysis catheter. The Journal of Vascular Access. 2012; 13: 126–127.

[6] Urban T, Wappler F, Sakka SG. Intra-arterial ECG leads of a positive P-wave potential during central venous catheterization. Anasthesiol Intensivmed Notfallmed Schmerzther. 2011; 46: 94–97. (In German)

[7] Nicholson T, Ettles D, Robinson G. Managing inadvertent arterial catheterization during central venous access procedures. CardioVascular and Interventional Radiology. 2004; 27: 21–25.

[8] Bowdle A. Vascular complications of central venous catheter placement: evidence-based methods for prevention and treatment. Journal of Cardiothoracic and Vascular Anesthesia. 2014; 28: 358–368.

[9] Guilbert MC, Elkouri S, Bracco D, Corriveau MM, Beaudoin N, Dubois MJ, *et al*. Arterial trauma during central venous catheter insertion: case series, review and proposed algorithm. Journal of Vascular Surgery. 2008; 48: 918–925; discussion 925.

[10] Kirkwood ML, Wahlgren CM, Desai TR. The use of arterial closure devices for incidental arterial injury. Vascular and Endovascular Surgery. 2008; 42: 471–476.

[11] Moller SM, Logason K, Karason S, Thorisson HM. Percutaneous thrombin injection of common carotid artery pseudoaneurysm without cerebral protection. Texas Heart Institute Journal. 2012; 39: 696–698.

[12] Shah PM, Babu SC, Goyal A, Mateo RB, Madden RE. Arterial misplacement of large-caliber cannulas during jugular vein catheterization: case for surgical management. Journal of the American College of Surgeons. 2004; 198: 939–944.

[13] Slama M, Novara A, Safavian A, Ossart M, Safar M, Fagon JY. Improvement of internal jugular vein cannulation using an ultrasound-guided technique. Intensive Care Medicine. 1997; 23: 916–919.

[14] Sznajder JI, Zveibil FR, Bitterman H, Weiner P, Bursztein S. Central vein catheterization: failure and complication rates by three percutaneous approaches. Archives of Internal Medicine. 1986; 146: 259–261.

[15] Schwartz AJ, Jobes DR, Greenshow DE, Stephenson LW, Ellison N. Carotid artery puncture with internal jugular cannulation. Anesthesiology. 1979; 51: S160.

[16] Reuber M, Dunkley LA, Turton EPL, Bell MDD, Bamford JM. Stroke after internal jugular venous cannulation. Acta Neurologica Scandinavica. 2002; 105: 235–239.

[17] Heath K, Woulfe J, Lownie S, Pelz D, Munoz D, Mezon B. A devastating complication of inadvertent carotid artery puncture. Anesthesiology. 1998; 89: 1273–1275.

[18] Zaidi NA, Khan M, Naqvi HI, Kamal RS. Cerebral infarct following central venous cannulation. Anaesthesia. 1998; 53: 186–191.

[19] Szkup PL. A minimally invasive technique for closing an iatrogenic subclavian artery cannulation using the Angio-Seal closure device: two case reports. Journal of Medical Case Reports. 2012; 6: 82.

[20] Wallace MJ, Ahrar K. Percutaneous closure of a subclavian artery injury after inadvertent catheterization. Journal of Vascular and Interventional Radiology. 2001; 12: 1227–1230.

[21] Berlet MH, Steffen D, Shaughness G, Hanner J. Closure using a surgical closure device of inadvertent subclavian artery punctures during central venous catheter placement. CardioVascular and Interventional Radiology. 2001; 24: 122–124.

[22] Fraizer MC, Chu WW, Gudjonsson T, Wolff MR. Use of a percutaneous vascular suture device for closure of an inadvertent subclavian artery puncture. Catheterization and Cardiovascular Interventions. 2003; 59: 369–371.

[23] Bechara CF, Barshes NR, Pisimisis G, Kougias P, Lin PH. Management of inadvertent carotid artery sheath insertion during central venous catheter placement. JAMA Surgery. 2013; 148: 1063.

[24] Lee WA, Brown MP, Nelson PR, Huber TS, Seeger JM. Midterm outcomes of femoral arteries after percutaneous endovascular aortic repair using the Perclose technique. Journal of Vascular Surgery. 2008; 47: 919–923.

[25] Pikwer A, Acosta S, Kölbel T, Malina M, Sonesson B, Akeson J. Management of inadvertent arterial catheterization associated with central venous access procedures. European Journal of Vascular and Endovascular Surgery. 2009; 38: 707–714.

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