Right thyrocervical trunk rupture after right internal jugular vein puncture: a case report and systematic review of the literature

Yuko Ono1,2*, Eisuke Ueshima3, Nobuto Nakanishi1, Kazuaki Shinohara2, Isamu Yamada1 and Joji Kotani1

Abstract

Background: Thyrocervical trunk rupture is an unusual, but critical, complication associated with central venous catheter (CVC) placement. The management of this complication has not been fully determined because it is rare.

Case presentation: A 53-year-old Japanese woman with anorexia nervosa developed refractory ventricular fibrillation. After returning spontaneous circulation, a CVC was successfully placed at the initial attempt in the right internal jugular vein using real-time ultrasound guidance. Immediately after CVC placement, she developed enlarging swelling around the neck. Contrast-enhanced computed tomography showed massive contrast media extravasation around the neck and mediastinum. Brachiocephalic artery angiography showed a “blush” appearance of the ruptured right thyrocervical trunk. After selective arterial embolization with 33% N-butyl-2-cyanoacrylate, the extravasation completely disappeared and hemostasis was achieved.

Conclusion: Our findings suggest that severe vascular complications arising from CVC placement can occur in patients with a fragile physiological state. Endovascular embolization is an effective treatment for such complications.

Keywords: Accidental arterial puncture, Central venous catheter placement, Mechanical complication

Background

Central venous catheter (CVC) placement is a common and crucial intervention for managing critically ill patients and one of the most essential skill competencies for anesthesiologists. The internal jugular vein (IJV) is the preferred site for CVC placement, but life-threatening mechanical complications can occur associated with IJV puncture [1, 2]. One of the most common mechanical complications associated with IJV cannulation is an accidental arterial puncture, mainly the carotid artery [3] because of its anatomical proximity to the IJV. Additionally, accidental arterial puncture can occur in the vertebral artery [4], innominate artery [5], internal mammary artery [6], and thyrocervical trunk [7–16]. Thyrocervical trunk rupture is an unusual, but life-threatening, complication associated with CVC placement. The detailed clinical situations, risk factors, and management of this complication have not been fully determined because it is rare [7–16]. Therefore, we report an illustrative case of this complication. We also conducted a comprehensive literature review of thyrocervical trunk injury after IJV puncture.

Case presentation

A 53-year-old Japanese woman with a 30-year clinical history of anorexia nervosa (155 cm, 32 kg, body mass index: 13.3 kg/m²) was found unconscious at home. On admission to the Emergency Department, she was in a coma with a consciousness level of 6 on the Glasgow Coma Scale (E3V1M2). Her other vital signs initially recorded in the Emergency Department were as follows: body temperature, 35.1°C; heart rate, 83 beats/
and CVC were inserted without resistance. Immediately withdrawal of the needle, and then a guide wire, dilator, dark-colored blood was smoothly aspirated during gentle puncture, and blood was not aspirated. Non-pulsatile was completely collapsed at the time of the US-guided procedural ultrasound (US) examination, no vascular-like structures were visible behind the posterior wall of the right IJV. The right IJV was punctured by an experienced cardiologist under US guidance with the short-axis out-of-plane technique using an 18-gauge introducer needle contained in an Arrow triple lumen central venous catheter kit (Teleflex Medical Japan, Tokyo, Japan). Although the angle and depth of the needle appeared to be appropriate if the patient had not been emaciated, the right IJV was tilted to the left by approximately 30°. On a pre-procedural ultrasound (US) examination, no vascular-like structures were visible behind the posterior wall of the right IJV. The right IJV was punctured by an experienced cardiologist under US guidance with the short-axis out-of-plane technique using an 18-gauge introducer needle contained in an Arrow triple lumen central venous catheter kit (Teleflex Medical Japan, Tokyo, Japan). Although the angle and depth of the needle appeared to be appropriate if the patient had not been emaciated, the right IJV was completely collapsed at the time of the US-guided puncture, and blood was not aspirated. Non-pulsatile dark-colored blood was smoothly aspirated during gentle withdrawal of the needle, and then a guide wire, dilator, and CVC were inserted without resistance. Immediately after the CVC placement, she developed enlarging swelling around the neck. Contrast-enhanced computed tomography showed massive contrast media extravasation around the neck and mediastinum (Fig. 1a and b, respectively), whereas the tip of the CVC was correctly placed in the right IJV. The patient was considered at a high risk for open repair. Therefore, transarterial embolization was planned. After 6-Fr short sheath introduction (Radifocus Introducer II; Terumo, Tokyo, Japan) from her right brachial artery, a pigtail catheter (4-Fr; Cook Medical, Bloomington, IN, USA) was advanced into the brachiocephalic trunk with the support of a 0.035″ hydrophilic guidewire (Radifocus guidewire M; Terumo, Tokyo, Japan). Brachiocephalic artery angiography showed a characteristic “blush” appearance of the ruptured right thyrocervical trunk (Fig. 1c). After selective arterial embolization using a microcatheter (Masters Parkway Soft; Asahi Intecc, Aichi, Japan) and 33% N-butyl-2-cyanoacrylate, the extravasation completely disappeared (Fig. 1d) and hemostasis was achieved. A schema of the operative course at the catheterization laboratory is shown in Figure S1 in the supplementary information file. After receiving 22 units of packed red blood cells, 20 units of fresh frozen plasma, and 20 units of platelet concentrate, the patient was returned to the intensive care unit where correction of body fluid imbalance, hypothermia, acidemia, and coagulopathy was continued. Secondary infection and multiorgan dysfunction developed approximately 2 weeks later, and the patient died from sepsis on hospital day 16. An autopsy was not performed because her family refused.

Systematic literature review
The search strategy was determined a priori by the survey team, which comprised anesthesiologists (YO and KS), an interventional radiologist (EU), emergency physicians (NN, IY, and JK), and a librarian (MJ, listed in the Acknowledgments). On June 2022, all reported cases of thyrocervical trunk injury associated with IJV puncture were searched for in the MEDLINE database from inception using the following keywords: “thyrocervical trunk” AND “internal jugular vein puncture”; “thyrocervical trunk” AND “central venous catheter”; “thyroid artery” AND “internal jugular vein puncture”; and “thyroid artery” AND “central venous catheter”. PubMed (https://pubmed.ncbi.nlm.nih.gov/) was used to search the MEDLINE database. Cross-referencing was also performed using the reference list of articles included in this review. The following types of articles were excluded from the analysis: (1) they were not case reports or case letters, (2) they were not in English, and (3) they did not describe thyrocervical trunk injury associated with IJV puncture. This search produced 25 articles of which 10
relevant reports and cases were included in this review [7–16] (Fig. 2). We reviewed the variables of age, sex, underlying medical conditions of the patients, number of punctures, use of real-time US guidance, characteristics of the operator, treatment, and outcome.

The clinical characteristics of thyrocervical trunk injury after IJV puncture described in this review, including our patient, are shown in Table 1. Seven articles described pseudoaneurysm of the thyrocervical trunk or its branches [7–13], three reported massive bleeding arising from the thyrocervical trunk or its branches [14, 15], and one reported CVC misplacement in the right inferior thyroid artery [16]. The cases in the literature review consisted of four men and seven women, aged 33 to 71 years. More than 80% (9/11) of thyrocervical trunk injuries were associated with a landmark puncture without using real-time US guidance. More than half (6/11) of the thyrocervical trunk injuries were associated with multiple (≥ 2) attempts. Aneurysm or active bleeding arising from a thyrocervical trunk injury was successfully managed by surgical repair (4/11) or endovascular treatment (5/11). Endovascular embolization using 33% N-butyl-2-cyanoacrylate for the treatment of vascular complications associated with CVC placement has not been reported previously.

Discussion
This case involved severe complications arising from the right IJV puncture. In our case, real-time US-guided venipuncture was used by an experienced physician, and the CVC was successfully placed on the initial attempt. However, the introducer needle accidentally crossed the lumen of the IJV, with a subsequent puncture of the thyrocervical trunk (Fig. 3). The present case highlights the requirement for increased attention when attempting interventional vascular procedures in patients with anorexia nervosa. In our patient, bleeding from the ruptured thyrocervical trunk extended from the neck to the mediastinum through the prevertebral space, which is a large and loose compartment only bounded by deep cervical fascia. Transarterial embolization was helpful in the diagnosis and treatment of the thyrocervical trunk rupture associated with CVC placement.

In our literature review, more than 80% of thyrocervical trunk injuries were associated with a landmark puncture. Our review also showed that more than 50% of thyrocervical trunk injuries were associated with multiple (≥ 2) attempts. The current results are in agreement with the previous observations, which showed that the complication rate associated with CVC placement increased when more than two punctures were required [19, 20].
Previous randomized, controlled trials [21, 22] indicated that real-time US-guided CVC placement in the IJV had a higher success rate of a first insertion attempt and a lower rate of arterial puncture than the landmark-guided technique. Our results, together with these previous findings [19–22], collectively support the strategy of limiting the number of puncture attempts by using real-time US guidance.

In this case, real-time US-guided venipuncture was used by a skilled physician, and a CVC was successfully placed in the IJV at the initial attempt. However, right thyrocervical trunk rupture occurred and was associated with CVC placement. There are several plausible factors that might have caused this complication. First, this patient was obviously emaciated (body mass index: 13.3 kg/m²) and malnourished. The skin, connective tissue, and vascular walls were thin and fragile, which may have made the introducer needle cross the lumen of the IJV. A previous study also showed that a low body mass index (< 20 kg/m²) was a risk factor of mechanical complications associated with CVC placement [23]. Second, patients with anorexia nervosa are likely to have vascular abnormalities [24]. In response to starvation and energy deprivation, the connective tissue of the vascular wall is considerably weakened, making the vascular structures vulnerable. Launay et al. also described the case of an 18-year-old woman with anorexia nervosa who developed radial artery injury leading to digital necrosis following a radial arterial puncture for blood gas analysis [25]. Their findings together with our experience suggest that health care providers should carefully consider the need for invasive vascular procedures in this tenuous patient population. Third, in addition to underlying thrombocytopenia and coagulopathy, our patient received continuous intravenous heparin administration for the prevention of thrombus in the akinetic ventricular apex. Although the abnormal coagulation profile was not the main cause of bleeding in this case, it could have been an aggravating factor in the rapid progression of the neck hematoma. This possibility indicates that
Table 1 Summary of the clinical characteristics of thyrocervical trunk injury after internal jugular vein puncture

| Reference number | Details of mechanical complications | Age (years)/sex | Underlying medical condition | Number of attempts | Use of real-time US guidance | Characteristics of the operator | Treatment | Outcome |
|------------------|-------------------------------------|-----------------|------------------------------|-------------------|-------------------------------|-------------------------------|-----------|---------|
| [7]              | Right thyrocervical trunk pseudoaneurysm | 33/female       | Suspected pulmonary embolism after emergency cesarean section | 1                  | Yes                           | NR                            | Endovascular repair with a balloon-expandable covered stent | Survival |
| [8]              | Right thyrocervical trunk pseudoaneurysm | 52/female       | Acute on chronic renal failure | Several times     | No                            | Nephrologist                  | Surgical ligation | Survival |
| [9]              | Right thyrocervical trunk pseudoaneurysm | 63/male         | Recurrent sepsis syndrome of an unknown source | Several times     | No                            | NR                            | Surgical ligation | Survival |
| [10]             | Right thyrocervical trunk pseudoaneurysm | 57/female       | Renal failure due to autosomal dominant polycystic kidney disease | NR                | No                            | Attending physician          | Surgical ligation | Survival |
| [11]             | Right inferior thyroid artery pseudoaneurysm | 54/female       | Severe esophagitis | Several times     | No                            | NR                            | Endovascular coil embolization | Survival |
| [12]             | Right inferior thyroid artery pseudoaneurysm | 51/female       | Elective right-sided hepatectomy because of hepatocellular carcinoma with liver cirrhosis | 1                  | No                            | Third year resident           | Endovascular coil embolization | Survival |
| [13]             | Right transverse cervical artery pseudoaneurysm | 46/male         | End-stage renal failure | Several times     | No                            | NR                            | Endovascular coil embolization | Survival |
| [14]             | Right thyroid artery injury | 49/male         | Repair of an ascending aortic aneurysm | 2                  | No                            | Attending anesthesiologist    | Observation | Survival |
| [15]             | Right superior thyroid artery rupture | 44/female       | End-stage renal failure | 2                  | No                            | NR                            | Endovascular coil embolization | Survival |
| [16]             | Central venous catheter misplaced in the right inferior thyroid artery | 71/male         | Left-sided hemi-hepatectomy because of central metastases of a rectal carcinoma | 1                  | No                            | Attending anesthesiologist    | Surgical repair | Survival |
| Current case     | Right thyrocervical trunk rupture | 53/female       | Anorexia nervosa and takotsubo cardiomyopathy | 1                  | Yes                           | Cardiologist                  | Endovascular embolization using 33% N-butyl-2-cyanoacrylate | Death    |

NR Not recorded, US Ultrasound
blood coagulation function should be determined before attempting to cannulate the IJV.

In this case, the right IJV collapsed during real-time US-guided puncture, and the thick introducer needle (18 gauge) was unintentionally deeply advanced. In such a situation, inadvertent artery cannulation may develop. Previous reports have shown that CVC misplacement in the carotid artery [26], vertebral artery [27], subclavian artery [28], and thyrocervical trunk [16] can occur associated with IJV puncture, regardless of the use of the US-guided technique. The management of the consequences of arterial placement of a large-bore catheter is challenging. Once the catheter is removed, direct manual pressure may be difficult to place on the artery because it is usually distal to the puncture site in the skin [16]. In fact, pulling the catheter out and applying manual pressure is associated with severe complications, such as persistent bleeding, hematoma, arteriovenous fistula, pseudoaneurysm, stroke, and death [2]. Therefore, a vascular surgeon should be consulted before removing the misplaced catheter [16]. The surgeon should decide whether to explore the vessel and what type of repair may be required.

Finally, this case illustrates the successful management of the thyrocervical trunk by endovascular treatment. Carotid angiography was helpful in the diagnosis and treatment of bleeding. After selective arterial embolization using 33% N-butyl-2-cyanoacrylate, extravasation completely disappeared and hemostasis was achieved. Our literature review also showed that more than half of the cases of aneurysms and intractable hemorrhage arising from thyroid artery injury were successfully managed by endovascular treatment. Although surgical exploration was another therapeutic option for controlling the hemorrhage, open repair was not considered appropriate in our patient because she was at a high risk of intraoperative bleeding and anastomotic leakage for concomitant comorbidities. Based on these observations, endovascular therapy appears to be a rapid and effective option for treating vascular accidents associated with CVC placement, especially in those with a fragile physiological status.

In conclusion, we report a right thyrocervical trunk rupture after a right IJV puncture in a Japanese woman with anorexia nervosa. The findings in this case suggest that severe mechanical complications arising from CVC placement can occur, especially in patients with a fragile physiological state. Our findings also suggest that endovascular embolization is an effective treatment for such complications. This case indicates the need for caution in all health care professionals who are involved in this common and important intervention.

Abbreviations
CVC: Central venous catheter; IJV: Internal jugular vein; US: Ultrasound.
Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s40981-022-00565-w.

Additional file 1: Fig. S1. Schema of the operative course at the catheterization laboratory.

Acknowledgements
The authors thank the following people: Ms. Mariko Jyukei (Librarian, Library for Medical Sciences, School of Medicine, Kobe University) for her pertinent advice in determining the search strategy using PubMed®, Nozomi Ono, M.D. (Department of Psychiatry, Hoshigaoka Hospital, Koriyama, Japan) for her assistance in reviewing the manuscript; and Ellen Knapp, PhD, from Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript. The authors also thank MEDICAL FIG. (https://medicalfig.medicaleducation.co.jp/) for the help in generating Fig. 3.

Authors' contributions
YO, EU, NN, IY, and JK contributed to managing the patient. All authors contributed to the construction of the systematic literature search strategy. YO performed the systematic literature search and drafted the initial manuscript. KS, IY, and JK supervised the undertaking of the systematic literature search and data collection. EU, NN, KS, IY, and JK critically reviewed the manuscript and participated in drafting the manuscript. All of the authors have read and approved the final manuscript.

Funding
The authors received no funding specifically for this work.

Availability of data and materials
The datasets used during the literature review are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Written informed consent was obtained from the patient for publication of this case report and the accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
The authors declare that they have no competing interests.

Author details
1. Department of Disaster and Emergency Medicine, Graduate School of Medicine, Kobe University, 7-5-2 Kusunoki-cho, Chuo-ku, Kobe, Hyogo 650-0017, Japan. 2. Department of Anesthesiology, Ohita General Hospital Foundation, Ohita Nishinouchi Hospital, 2-5-20 Nishinouchi, Koriyama, Fukushima 963-8558, Japan. 3. Department of Diagnostic and Interventional Radiology, Kobe University, Kobe, Japan.

Received: 20 July 2022 Revised: 7 September 2022 Accepted: 8 September 2022

Published online: 16 September 2022

References
1. McGee DC, Gould MK. Preventing complications of central venous catheterization. N Engl J Med. 2003;348:1123–33.
2. Kusminsky RE. Complications of central venous catheterization. J Am Coll Surg. 2007;204:681–96.
3. Kaytal N, Korzei A, Newey C. Inadvertent central arterial catheterization: an unusual cause of ischemic stroke. J Neurosci Rural Pract. 2018;9:155–8.
4. Abeysinghe V, Xu JH, Sieunarine K. Iatrogenic injury of vertebral artery resulting in stroke after central venous line insertion. BMJ Case Rep. 2017;2017:bcr2017222429.
5. Faraj J, Choudhary A, Ritter JC. Covered stenting as bail-out technique for central venous catheter malposition within the brachiocephalic trunk. Vasc Endovascular Surg. 2020;54:65–8.
6. Chemelli AP, Chemelli-Steingruber IE, Bonaros N, Luckner G, Millionig G, Seppi K, et al. Coil embolization of internal mammary artery injured during central vein catheter and cardiac pacemaker lead insertion. Eur J Radiol. 2009;71:269–74.
7. Palermo C, Sanfilico A, Giaquinta AT, Vigilco G, Veroux M, Veroux P. Mini-invasive treatment of a large pseudoaneurysm of the neck related to central venous catheter placement: a case report. Medicine (Baltimore). 2018;97:e11262.
8. Chalmers RT, Brittenden J, Bradbury AW. The use of endovascular stented grafts in the management of traumatic false aneurysms: a caveat. J Vasc Surg. 1995;22:337–8.
9. Elairny HA, Crockett D, Hussey J. False aneurysm of the thyrocervical trunk. South Med J. 1996;89:519–21.
10. Peces R, Navascues RA, Baltar J, Laurés AS, Alvarez-Grande J. Pseudoaneurysm of the thyrocervical trunk complicating percutaneous internal jugular-vein catheterization for haemodialysis. Nephrol Dial Transplant. 1998;13:1009–11.
11. Depek AH, Jammaldiniedine GW, Bou-Khalil PK. Inferior thyroid artery injury after attempts of internal jugular venous catheterization. J Cardiothorac Vasc Anesth. 2007;21:422–4.
12. Ruan J, Zhang C, Peng Z, Tang D, Feng Z. Inferior thyroid artery pseudoaneurysm associated with internal jugular vein puncture: a case report. BMC Anesthesiol. 2015;15:71.
13. Cuhaci B, Khoury P, Chvila R. Transverse cervical artery pseudoaneurysm: a rare complication of internal jugular vein cannulation. Am J Nephrol. 2000;20:476–82.
14. Silva FS. Neck haematoma and airway obstruction in a patient with goitre: complication of internal jugular venous cannulation. Acta Anaesthesiol Scand. 2003;47:626–9.
15. Jeganathan V, McElwaine JG, Stewart P. Ruptured superior thyroid artery from central vein cannulation: treatment by coil embolization. Br J Anaesth. 2001;87:302–5.
16. Schummer W, Schummer C, Piaxian M, Frober M, Settmacher U. ECG recording of central venous catheter misplaced in inferior thyroid artery. Br J Anaesth. 2005;94:296–9.
17. Kingiaya J, Iwasahi N, Tanaka R, Inayama Y, Takeuchi I. A fatal case of takotsubo cardiomyopathy secondary to refractory hypoglycaemia in severe starvation: an autopsy case report. Cureus. 2022;14:e23287.
18. Kikuchi K, Yasui-Furukyo N, Hasegawa C, Watahiki M, Inoue T, Shimoda K. Takotsubo cardiomyopathy after hypoglycaemia in a patient with anorexia nervosa. Ann Gen Psychiatry. 2021;20:39.
19. Lefrant JY, Muller L, De La Coussaye JE, Prudhomme M, Ripart J, Gouzes P, et al. Cardiac complications and failures of subclavian-vein catheterization. Int J Cardiol. 2002;88:1036–41.
20. Eisen LA, Narasimhan M, Berger JS, Mayo PH, Rosen MJ, Schneider RF. Mechanical complications of central venous catheters. J Intensive Care Med. 2002;28:23–9.
21. Lefrant JY, Muller L, De La Coussaye JE, Prudhomme M, Ripart J, Gouzes P, et al. Risk-factors of failure and immediate complication of subclavian vein catheterization in critically ill patients. Intensive Care Med. 2006;32:2140–6.
22. Bansal R, Agarwal SK, Tiwari SC, Dash SC. A prospective randomized study to compare ultrasound-guided with nonultrasound-guided double lumen internal jugular catheter insertion as a temporary hemodialysis access. Ren Fail. 2005;27:561–4.
23. Karakitsos D, Labropoulos N, De Groot E, Patrianiakos AP, Kourakis G, Poularas J, et al. Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. Crit Care. 2006;10:R162.
24. Mansfield PF, Hohn DC, Forrage BD, Geergiuc MH, Ota DM. Complications and failures of subclavian-vein catheterization. N Engl J Med. 1994;331:1735–8.
25. Sachs KV, Harriere B, Mehler PS, Kranz MJ. Cardiovascular complications of anorexia nervosa: a systematic review. Int J Eat Disord. 2016;49:238–48.
26. Stone MB, Hern HG. Inadvertent carotid artery cannulation during ultrasound guided central venous catheterization. Ann Emerg Med. 2007;49:720.

27. Lind RC, Arvidsson B. Placement of a central venous catheter into the right vertebral artery despite ultrasound guidance. Eur J Vasc Endovasc Surg. 2019;58:679.

28. Paliwal B, Kamal M, Purohit A, Rana K, Chouhan DS. Accidental subclavian artery catheterization during attempted internal jugular central venous catheter placement: a case report. J Clin Diagn Res. 2015;9:UD03–UD5.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.