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Inadvertent Arterial Trauma during Internal Jugular Vein Catheterization

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Summary

To ensure safe placement of a central venous catheter (CVC), the potential accidents that may occur due to inadvertent arterial puncture through the internal jugular vein (IJV), should be carefully considered. Inadvertent common carotid arterial puncture during IJV catheterization is well recognized. However, other arteries including the subclavian, vertebral, transverse cervical and inferior thyroid arteries may be located behind the IJV, and are at risk of mispuncture. In the present study, we searched for case reports related to arterial trauma during IJV catheterization. In the present report, we describe information regarding CVC placement, including the historical and anatomical background, and the need for using ultrasonography during placement.

Through our search, we obtained 9 cases of vertebral arterial, 7 cases of subclavian arterial, 1 case of thyrocervical trunk, 4 cases of transverse cervical arterial, and 1 case of inferior thyroid arterial insults that were caused inadvertently around the IJV. Of the 22 cases, 2 involved insults in children. Real-time ultrasonographic guidance was employed in 5 recent cases, and surgical repair was required in12 of the 22 cases.

In most of the cases of arterial puncture not involving the CCA, the surgeons did not use ultrasonography. Static ultrasonography via the anatomic landmark approach for locating the IJV, and combining the pre-procedural ultrasonographic assessment with a real-time ultrasound-guided venipuncture are recommended during CVC placement. The ultrasound-guided insertion technique requires education, training and practice. The presence of small arteries located behind the IJV should be carefully considered, and their presence in this position should be examined, prior to puncturing of the IJV. However, it should be noted that rare complications develop during CVC placement with or without ultrasonographic guidance. Therefore, the technique involving ultrasonographic guidance is not completely reliable.

Introduction

To ensure safe placement of a central venous catheter (CVC), the potential accidents that may occur due to inadvertent arterial puncture through the internal jugular vein (IJV), should be carefully considered. A previous review study has described the manner in which mispuncturing of the common carotid arteries (CCAs) or subclavian arteries during IJV catheterization can be avoided. Moreover, arterial punctures can be avoided during arterial cannulation by using a tube manometer to verify venous access [1]. Studies investigating the relationships between the CCAs and IJVs indicated that these vessels overlapped in 70–90% of cases [2-6]. Neck rotation increases overlapping ratio between the CCA and IJV [7]. Therefore, prior to performing IJV punctures, it is essential to assess the overlapping of these arteries using ultrasonography.

Only limited information on the puncture of IJV or subclavian veins has been mentioned in reports related to arterial trauma during CVC insertion [8,9]. However, studies have reported on the presence of small arteries such as the vertebral artery [10,11], thyrocervical trunk [12,13], suprascapular artery, transverse cervical artery [14-18], and inferior thyroid artery [19], that are occasionally located just behind the IJV [11,13].

We performed an extensive literature search through PubMed, Google, science journals and textbooks to identify such studies, using key words such as internal jugular vein, subclavian artery, vertebral artery, thyrocervical trunk, transverse cervical artery and inferior thyroid artery. In the present report, we describe information regarding CVC placement, including the historical and anatomical background, and the need for using ultrasonography during placement.

Case Presentations

Table 1 demonstrates summary of case reports. Through our search, we noted 9 cases of vertebral arterial [10,20-27], 7 cases of subclavian arterial [28-34], 1 case of thyrocervical trunk [12], 4 cases of transverse cervical arterial [14,15,17,18], and 1 case of inferior thyroid arterial [19], insults that were caused inadvertently around the IJVs. These cases were associated with needle punctures [10,15,19], catheter cannulations [14,20,21,26,29-33], hemothorax [12,21,28-31], pseudoaneurysms [12,17,18,23,24], arteriovenous fistulas [18,22,25,26,33,34], and a dissection [27]. In 2 of the 22 cases, the patients were children and the insults resulted from needle punctures [10,15].

Of the 22 reported cases, real-time ultrasonographic guidance was employed only in 5 recent (2011-2013) cases [10,14,15,32,33]. In one case of vertebral arterial puncture [10], although the surgeon noted the presence of an artery behind the IJV, puncturing of the vertebral artery could not be avoided because of its position just behind the IJV. In one case of CVC placement through the transverse cervical artery with a 22-G metal needle using a guidewire [14], and another case of inadvertent puncture of a small artery located just behind the IJV [15], the presence of these arteries behind the IJV was not known. In cases involving cannulation of the subclavian artery [32,33], the position of the subclavian arterial relative to the IJV position may not have been determined, despite the use of ultrasonography.

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Surgical repair was required in 12 of the 22 cases. In a case of a pseudoaneurysm of the thyrocervical trunk, the pseudoaneurysm was resected and the arterial branch was ligated [12]. In a case of a vertebral artery, a large amount of associated hematoma was removed, and a lacerated vertebral artery was tied off [21]. In a case of vertebral artery pseudoaneurysm, the site of hemorrhage was sutured [22]. In another case of vertebral and subclavian artery pseudoaneurysm, the pseudoaneurysms were resected [23]. Moreover, in a case of vertebral arteriovenous fistula, multiple small communicating veins draining into the vertebral vein, and a single communication between the vertebral artery and vein were ligated and divided [25]; thereafter, the vertebral arteriovenous fistula was excised. In another case of vertebral arteriovenous fistula, the anastomosis was completed using the triangulation technique [26].

Furthermore, in a case of a massive hemothorax, the right subclavian artery was found to be lacerated at its origin from the brachiocephalic artery [28]; the subclavian artery was disconnected from the internal carotid, and then re-anastomosed. In another case of hemothorax and subclavian artery laceration, a right thoracotomy and sternotomy was performed, and more than 2 L of clotted blood was removed [29]. In a case of subclavian artery injury, 2 L of blood was removed via a thoracotomy; in addition, a puncture in the first part of the subclavian artery was identified and repaired by suturing [30]. In a case of hemomediastinum, 1.5 L of clotted blood was removed and 5-mm laceration of subclavian artery was repaired [31]. Moreover, in a case of subclavian arteriovenous fistula, a 7.5 French hemodialysis catheter was removed and the subclavian artery was successfully repaired [32]. Removal of a 12-gauge double lumen catheter and subclavian artery repair were done successfully [33].

Discussion

Through our search of the PubMed and other database, we identified 22 cases of inadvertent arterial punctures that did not involve the CCA during IJV cannulation, which were noted primarily in adults. In 12 cases with severe injury, surgical interventions were required. Therefore, we believe that the presence of small arteries, other than the CCA, located behind the IJV should be carefully considered, and their presence in this position should be examined prior to puncturing of the IJV.

Static ultrasonography with the anatomic landmark approach for locating the IJV [35,36], and combining the pre-procedural ultrasonographic assessment with a real-time ultrasound-guided venipuncture [37], are recommended during CVC placement. The anatomical structures of the vertebral [11] and transverse cervical [13,15,16] arteries can be observed by using ultrasonography, including color flow Doppler imaging.

Multiple published guidelines and recommendations support the clinical utility of ultrasound-guided IJV puncture [35-41]. However, these guidelines and recommendations on vascular access have not referred to the small vascular structures located around the IJV. Only O'Leary and Bodenham [42] have suggested that confirmation of the presence of small arteries using color flow Doppler imaging is vital.

For CVC placement, anatomical information of arteries around

No	Year	Injured artery (A)	Types of trauma	Age	Cath or needle	Meth or Appr	Treatment
10	2012	Vertebral A	Needle puncture	12 m	24G needle	USG	Pressure
20	2007		Cath cannulation	40 y	–	–	Remov
21	1981		Cath cannulation Hemothorax	55 y	Bard I-Cath	14G Introducer	Surgery after Remov
22	1992		AV fistula	72 y	22G needle	–	Surgery
23	2011		Pseudoaneurysm	48 y	–	–	Surgery
24	2011		Pseudoaneurysm	36 y	–	LM	Medical
25	1980		AV fistula	36 y	14G needle	20G	Surgery
26	1999		Cath cannulation AV fistula	54 y	S-G	Posterior	Surgery after Remov
27	2004		Dissection	63 y	–	–	Remov Pressure
28	1990	Subclavian A	Hemothorax Laceration	56 y	14G DL	Boulanger	Surgery
29	1998		Cath cannulation Hemothorax	47 y	7F TL	Seldinger	Surgery after Remov
30	2002		Cath cannulation hemothorax	66 y	TL	Anterior	Surgery after Remov
31	2003		Cath cannulation Hemothorax, laceration	61 y	8.5F sheath	22G needle	Surgery after Remov
32	2012		Cath cannulation	65 y	7.5F	USG	Remov at surgery
33	2011		Cath cannulation AV fistula	63 y	12F DL	USG	Remov at Surgery
34	2013		AV fistula	45 y	11.5F	LM	Medical
12	1998	Thyrocervical trunk	Hemothorax Pseudoaneurysm	57 y	11.5F DL	–	Surgery after Remov
14	2011	Transverse cervical A	Cath cannulation	50 y	12G DL	USG	Remov and Pressure
15	2013		Needle puncture	15 m	24G needle	USG	Pressure
17	1995		Pseudoaneurysm	–	7F TL	–	Embolization
18	2000		Pseudoaneurysm AV fistulas	46 y	Unsuccessful cannulation	LM	TCA occlusion
19	2007	Inferior thyroid A	Needle puncture	54 y	Unsuccessful cannulation	–	Embolization

No: reference number; Year: published year; m: months old; y: years old; Meth or Appr: method or approach.
Cath: catheter; G: gauge; F: French size; S-G: Swan-Ganz catheter; DL: double lumen catheter; TL: triple lumen catheter; AV: Arteriovenous; USG: ultrasonographic guidance; LM: landmark guidance; Remov: cath removal –: not mentioned

Table 1: Cases of inadvertent arterial trauma through the internal jugular vein.

the IJV should be well known. The brachiocephalic artery bifurcates into the right subclavian and the right CCA. The right vertebral artery branches from the subclavian artery. In addition, the thyrocervical trunk arises from the subclavian artery adjacent to the vertebral artery and branches into the suprascapular artery, transverse cervical artery and inferior thyroid artery.

The use of appropriate cannulation techniques involving real-time ultrasonographic guidance for avoiding puncturing of the CCA has been widely reported in the literature [39,43]. However, in a previous study, video analysis indicated accidental arterial cannulation of 5 CCAs and 1 femoral artery, despite the use of real-time ultrasonographic guidance [44]. Simulation models have indicated that penetration of the posterior wall of the IJV is unavoidable in certain cases [45,46]. Therefore, the technique involving ultrasonographic guidance is not completely reliable.

The ultrasound-guided insertion technique requires education, training, and practice [35,36,39,40]. In most of the cases of arterial puncture not involving the CCA [12,17-31,34], the surgeons did not use ultrasonography. Moreover, the presence of arteries behind the IJV has not been completed studied [10,14,15].

Therefore, it is essential that the position of the arteries around the IJV should be confirmed using color flow Doppler imaging, prior to puncturing. It would be difficult to identify the small arteries located behind the IJV, without using color flow Doppler imaging [10,11,15,16,42]. In addition, it is recommended that the position of the catheter tip should be confirmed using chest radiography, fluoroscopy or continuous electrocardiography [36].

Of 12 cases of surgical repair, 4 cases involving subclavian arterial cannulations underwent pre-surgical removal of large bore catheters that were inserted into the arteries prior to surgical exploration, and 1.5–2 L of blood was removed from the thorax during the surgery. It is essential that vascular surgeons or endovascular specialists should be consulted, prior to the removal of catheters from the arteries [8].

In the present study, we described 7 cases involving subclavian arterial trauma. Guilbert et al. [8] state that the low IJV approach should be carefully considered, as it may injure not only the CCA, but also the subclavian artery or innominate vessels. However, the presence of the subclavian artery behind the IJV has not been examined using ultrasound imaging, and further studies are required in order to elucidate information on the manner in which puncturing of the subclavian artery can be avoided during IJV puncture.

In the United States alone, more than 5 million central venous catheter placement procedures were performed, with a mechanical complication rate of 5% to 19% [39,40]. Although the present study could not assess all the published reports concerning inadvertent arterial puncture related to the IJV, the rare complications that have occurred during placement of CVCs with or without ultrasonographic guidance should be carefully considered.

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