Asian Journal of Surgery (2019) 42, 362–366

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-asianjournalsurgery.com

ORIGINAL ARTICLE

Validation of the ipsilateral nipple as the needle directional guide during right internal jugular vein catheterization: A prospective observational study

Sanghyun Ahn [a], Ho Geol Ryu [b,*], Chang-Hoon Koo [c], Seungeun Choi [b], Ji-Hyun Lee [b], In-Ki Jang [b]

[a] *Department of Surgery, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, South Korea*
[b] *Department of Anesthesiology, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, South Korea*
[c] *Department of Anesthesiology, CHA Bundang Medical Center, CHA University College of Medicine, Seongnam, South Korea*

Received 28 February 2018; received in revised form 2 April 2018; accepted 9 April 2018
Available online 25 May 2018

KEYWORDS
Internal jugular vein catheterization;
Ipsilateral nipple;
Common carotid artery

Summary *Background:* The ipsilateral nipple has been used as a directional guide for needle advance during internal jugular vein (IJV) catheterization. We attempted to validate the utility of the ipsilateral nipple during IJV catheterization.
Methods: One hundred and two patients scheduled for elective surgery were enrolled. In the 15° Trendelenberg position with 30° head rotation, the apex of the triangle formed by the sternocleidomastoid muscle and the clavicle was identified. The angle formed by the line connecting the apex and the ipsilateral nipple and the actual course of the IJV was measured. The distance between the apex of the anatomical triangle and the IJV center identified were measured via ultrasound.
Results: The angle formed by the line connecting the apex and the ipsilateral nipple and the IJV was 16 ± 7.6° and was greater in females than males (14.8 ± 1.1 vs 17.4 ± 1.0°, P = 0.043). Regression analysis showed that height, weight, gender, and age did not affect the angle as an independent factor. The apex of the anatomical triangle was 0.5 cm medial to the IJV center and was shorter in females compared to males (0.33 ± 0.12 vs 0.6 ± 0.09 cm, P = 0.039).
Conclusion: Our study shows that when the needle is inserted at the apex of the anatomical triangle directed towards the ipsilateral nipple, it crosses the IJV at 16°. Since the common carotid artery is usually medial to the IJV, directing the needle towards the ipsilateral

* Corresponding author. Department of Anesthesiology and Pain Medicine, Seoul National University Hospital, Seoul National University College of Medicine, 101 Daehak-ro, Jongno-gu, Seoul, 110-744, South Korea. Fax: +82 2 747 5639.
E-mail address: hogeol@gmail.com (H.G. Ryu).

https://doi.org/10.1016/j.asjsur.2018.04.003

nipple seems to be a safe way to avoid the common carotid artery and successfully puncture the IJV.

1. Introduction

The internal jugular vein (IJV) catheterization has been performed for variety of purposes, including monitoring central venous pressure and administering fluids or drugs. For catheterization of the IJV, the use of real-time ultrasound is recommended whenever available.[1] However, central vein catheterization using anatomical landmarks are still taught and used in circumstances where ultrasound is not available.

Of the many different traditional catheterization techniques that do not incorporate the ultrasound, the 'central' approach is the most widely described and used.[2] To successfully cannulate the IJV, most medical textbooks recommend the apex of the triangle formed by the two heads of the sternocleidomastoid (SCM) muscles the needle insertion point.[3] For direction of advancement of the needle, the ipsilateral nipple is suggested.[4]

The rationale for using the apex of the triangle formed by the two SCM muscle heads and the ipsilateral nipple as a directional guide is unclear. It can be speculated that the intention is to avoid puncturing the common carotid artery (CCA), which is usually medial to the IJV or to increase the likelihood of the puncture needle cross and meet the IJV to maximize the success rate of catheterization, or both. In either case, there are no data in the medical literature that provides a relevant basis to support this approach. We attempted to validate the credibility of the ipsilateral nipple as the directional guide during right IJV catheterization and also the appropriateness of the apex of the triangle formed by the two SCM muscle heads as an insertion point.

2. Methods

Our study protocol abided by the WMA declaration of Helsinki regarding ethical principles for medical research involving human subjects and was approved by the Boramae Medical Center institutional review board (06-2011-115). The study protocol was registered at clinicaltrials.gov (NCT01347463). Patients were enrolled in the study after obtaining written informed consent.

2.1. Patient population

Adult patients over the age of 18, scheduled to undergo elective surgery under general anesthesia were screened for enrollment. Patients with anatomical anomaly in the cervical area, neck mass, breast lesions, or previous history of neck or breast surgery were excluded. Patients with a body mass index greater than 30 kg/m^2 were also excluded.

2.2. Study protocol

After induction of anesthesia and intubation using 2 mg/kg of propofol, 0.1 mg/kg of vecuronium, and sevoflurane or desflurane, the operating table was tilted to the 15° Trendelenburg position with the patients in the supine position. A 1-L saline bag was placed under the right shoulder to facilitate right neck exposure. Patients' head was rotated 30° towards the left.

The two heads of the right SCM muscle were identified by palpation and needle insertion point was marked at the apex of the triangle formed by the SCM muscle and the clavicle. A line connecting the needle insertion point and the right nipple was drawn. Under ultrasound guidance (Edge™, Sonosite, Bothell, WA, USA), the center of the IJV at the cricoid cartilage level was identified and marked. The center of the IJV at the level just above the clavicle was also marked and the actual course of the IJV was drawn by connecting the two marks. The relationship between the IJV and the CCA were identified with the ultrasound at the level of the cricoid cartilage level. Identification of anatomical landmarks, marking points and drawing lines, ultrasound use, and measurement of lengths and angles were performed by one senior resident (IK Jang) for all of the patients. IJV catheterizations were only simulated and not performed.

2.3. Outcomes

The primary outcome was the angle between the line connecting the ipsilateral nipple and the apex of the triangle formed by the SCM muscle and the clavicle and the actual course of the IJV (Fig. 1). The distance between the ipsilateral nipple and the intersection between the line connecting the nipples and the extended line of the course of the IJV was measured. The difference between the apex of the triangle formed by the SCM muscle and the clavicle and the center of the IJV at the cricoid cartilage level was also recorded.

The relationship between the CCA and the IJV at the cricoid cartilage level was also recorded and classified as follows: CCA is medial to the IJV with no overlap, CCA is medial to the IJV with $<$50% overlap, CCA is underneath IJV with $>$50% overlap, CCA is lateral to the IJV with $<$50% overlap, CCA is lateral to the IJV with no overlap.

2.4. Statistical analysis

One sample t-test was performed to see if there was a difference between the line connecting the apex of the triangle formed by the SCM muscle the ipsilateral nipple

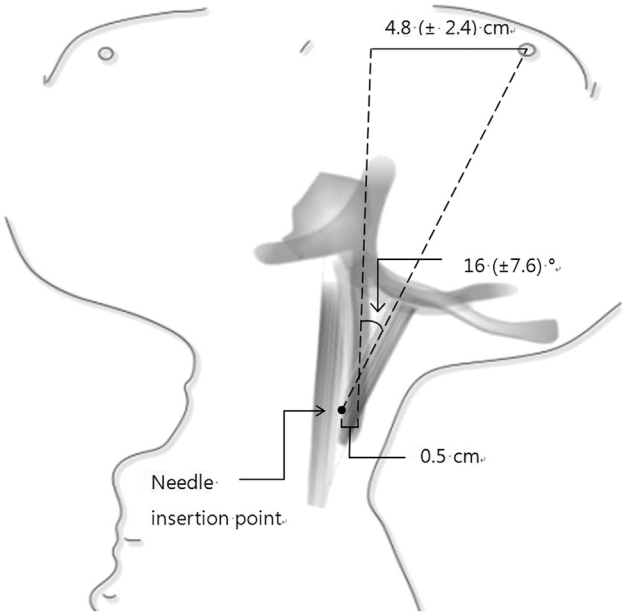

Figure 1 Schematic illustration of study outcome measurement. The average angle formed between the actual course of the IJV and the line connecting the apex of the anatomical triangle and the ipsilateral nipple was 16 (±7.6) degrees. The apex of the anatomical triangle was on average 0.5 cm medial to the center of the IJV. The extended course of the IJV crossed the line between the two nipples at 4.8 (±2.4) cm medial to the ipsilateral nipple.

and the actual course of the IJV. Difference in the angle between the line connecting the ipsilateral nipple and the actual course of the IJV according to sex was analyzed by using the two-sample t-test. Regression analysis was performed to evaluate factors that may be associated with the angle, which included height, weight, gender and age. The difference between the apex of the triangle formed by the SCM muscle and the clavicle and the center of the IJV at the cricoid cartilage level was also analyzed using the one sample t-test. A p-value of less than 0.05 was considered statistically significant.

3. Results

A total of 102 patients were enrolled in the study. Patient characteristics are summarized in Table 1.

The angle formed between the actual course of the IJV and the line connecting the apex of the anatomical triangle and the ipsilateral nipple was 16 ± 7.6 (mean ± SD) degrees. The angle was significantly greater in females compared to males (14.8 ± 1.1 vs 17.4 ± 1.0°, P = 0.043) Regression analysis did not identify height, weight, gender, or age as independent factors that affect the angle (Table 2). The extended course of the IJV crossed the line between the two nipples at 4.8 (±2.4) cm medial to the ipsilateral nipple.

The apex of the anatomical triangle was 0.47 ± 0.75 cm medial to the center of the IJV. The center of the IJV was at or lateral to the apex of the anatomical triangle in 89.2% (91/102 patients) of the patients. The distance between the center of the IJV and the apex of the anatomical triangle was significantly shorter in females compared to males (0.33 ± 0.12 vs 0.6 ± 0.09 cm, P = 0.039).

The relationship between the CCA and the IJV showed that the CCA either overlapped medially or was underneath the IJV in 94/102 patients (Fig. 2). None of the patients had a CCA lateral to the IJV with <50% overlap or CCA lateral to the IJV with no overlap.

Table 1 Patient characteristics.

Variables	
Sex (M:F)	53:49
Age (years)	53.9 ± 15.8 (18–83)
Height (cm)	161.3 ± 8.9 (140.4–183.2)
Weight (kg)	61.5 ± 10.5 (38.2–85.6)
BMI (kg/m^2)	23.6 ± 3.2 (15.1–29.8)

Data are expressed as mean ± SD (range).

4. Discussion

Our study showed that when the needle is inserted at the apex of the anatomical triangle formed by the SCM muscle and the clavicle and directed towards the ipsilateral nipple for IJV catheterization, it crosses the course of the IJV at an average angle of 16°. Our study also showed that the apex of the anatomical triangle is medial to the center of the IJV by an average of 0.5 cm. The CCA was medial to the IJV in 93% of the cases and never lateral to the IJV.

Ultrasound guidance for IJV catheterization has been shown to be safer and more successful compared to using anatomical landmarks for guidance[5] and are recommended in clinical practice guidelines.[6,7] But, limitations in availability exist in various circumstances, especially in resource-poor countries. Therefore, catheterization methods utilizing the surface anatomical landmarks may still have a role and should be taught as an alternative technique for central venous catheterization.[8] Nevertheless, it seems clear that ultrasound-guided central venous catheterization will be the norm.

The ipsilateral nipple has been taught and used as a directional guide for needle advance during catheterization of the IJV using the central approach.[4] However, the rationale behind this approach is unclear and has no relevant data in the medical literature. Considering that the course of the IJV

Table 2 Logistic regression of factors potentially associated with increased angle between the IJV and the line connecting the apex of the anatomical triangle and the ipsilateral nipple.

	Coefficient	Standard error	95% confidence interval	P-value
Sex	2.03	2.34	(−2.55, 6.61)	0.386
Age	−0.06	0.05	(−0.16, 0.05)	0.295
Height	−0.06	0.16	(−0.37, 0.25)	0.711
Weight	0.03	0.09	(−0.15, 0.21)	0.727

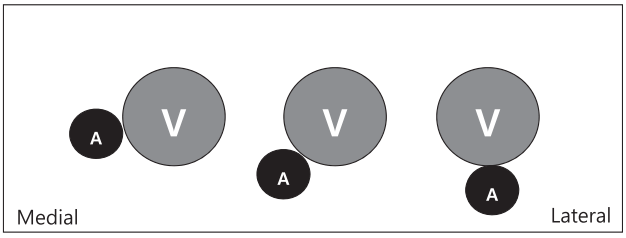

Figure 2 Relationship between common carotid artery and internal jugular vein at the cricoid cartilage level. The carotid artery was medioinferior to the internal jugular vein in 56/102 (54.9%) patients. It was medial to the IJV in 38/102 (37.1%), inferior to the IJV in 8/102 (7%) and never lateral to the IJV. CA: common carotid artery, IJV: internal jugular vein.

runs laterally parallel to the CCA, a plausible speculation would be that using the ipsilateral nipple as a directional guide increases the possibility of puncturing the IJV while limiting the chance of CCA puncture. Our study results suggest that the ipsilateral nipple is an appropriate landmark for needle advance, especially when the insertion point is the apex of the triangle formed by the SCM muscle and the clavicle. Considering that the apex of the triangle formed by the SCM muscle and the clavicle is slightly medial to the center of the IJV and that the CCA is almost never lateral to the IJV (as shown in our results), the central approach directs the needle away from the CCA but towards the IJV. With an appropriate vertical insertion angle, this approach inherently increases the probability of successful catheterization while decreasing the risk of CCA puncture. However, since the CCA is directly below the IJV in approximately 8% of patients, caution should be taken when catheterization is not successful with initial attempts.

The angle was significantly greater in females compared to males, which is anatomically self-explanatory. The difference, although statistically significant, was small and considered to have no clinical implications. In addition, multivariate regression analysis showed that gender, as well as age, height, or weight did not influence the angle formed between the actual course of the IJV and the line connecting the apex of the anatomical triangle and the ipsilateral nipple. Our results may not be feasible in patients with large and/or sagging breasts, as the size of the breast was not taken into account.

Many studies have evaluated the anatomic relationship between neck vessels and anatomical landmarks in various circumstances to find ways to increase the success rate of IJV catheterization. The failure rate of right IJV catheterization increases when head rotated 30° compared to neutral position because it increases the distance from the apex of the anatomical triangle to the center of the right IJV more medially (0.83 ± 1.03 cm vs. 0.28 ± 0.78 cm).[9] Another study suggest that the head should not be turned beyond 45° because the simulated needle did not hit the CCA until the head was rotated at least 30° but CCA hit rate was higher at 45° and 60°.[8] Our study was performed with the head rotated away by 30° because it was our usual practice and suggested in most textbooks.

Other studies focused on interventions to increase the diameter of IJV which would in turn increase the success rate of IJV cannulation. The cross-sectional area of IJV increased with 10cmH_2O of PEEP[10] and when the patient was positioned 15° Trendelenburg compared to supine position.[11] Accordingly, patients in our study were positioned 15° Trendelenburg for measurements, which also was the usual practice at our institution.

The relationship between the CCA and the IJV shows some variation among individuals. In most patients (54.9%), the IJV lies anterior and slightly lateral to the CCA. In 37.1% of patients, the IJV was completely lateral to the CCA whereas the IJV was directly above the CCA in 7% of patients (Fig. 2). This finding is consistent with previous reports in adult and pediatric population. The reported incidence of anterolateral location of the IJV in relation to the CCA was between 70.8% and 82%.[12,13] When the patient's head is rotated >30°, overlap between the two vessels significantly increased (57.5% vs. 95%).[14]

There are several limitations in our study. First, our study was an observational simulation study and actual catheterization was not performed in our patients. The objective of our study was to see whether the ipsilateral nipple was a suitable landmark for guiding needle advance during IJV catheterization. Second, identification of the apex of the SCM triangle and cricoid cartilage may have been influenced by the investigator's experience. To minimize this effect, a single experienced investigator determined all landmarks. Third, our study was limited to right IJV catheterization. The right IJV is the preferred site for central venous catheterization due to its accessibility and safety. One should be cautious when extrapolating our findings to left IJV catheterization. Lastly, our patient population was relatively lean Asians. Application of our results may be of limited value in other ethnicity and in patients with different body habitus (ex. Large breasts). Nevertheless, our data may provide better understanding of the underlying anatomy, leading to increased central venous catheterization success rate where ultrasound is not available.

In summary, the ipsilateral nipple seems to be an adequate directional guide for needle advance during IJV catheterization. When using the apex of the anatomical triangle as the needle insertion point, the needle meets the IJV at 16° and is directed away from the common carotid artery.

Conflicts of interest

The authors have no conflict of interest to declare.

References

1. American Society of Anesthesiologists Task Force on Central Venous Access, Rupp SM, Apfelbaum JL, et al. Practice guidelines for central venous access: a report by the American Society of Anesthesiologists Task Force on Central Venous Access. *Anesthesiology*. 2012;116(3):539—573.
2. Daily PO, Griepp RB, Shumway NE. Percutaneous internal jugular vein cannulation. *Arch Surg*. 1970;101(4):534—536.
3. Jin Lee J, Sook Gwak M, Yang M, Soo Kim G. A new method of internal jugular vein catheterization using the cricoid cartilage

and the external jugular vein as a landmark. *Am J Emerg Med*. 2006;24(6):697—701.
4. Graham AS, Ozment C, Tegtmeyer K, Lai S, Braner DA. Videos in clinical medicine. Central venous catheterization. *N Engl J Med*. 2007;356(21):e21.
5. Brass P, Hellmich M, Kolodziej L, Schick G, Smith AF. Ultrasound guidance versus anatomical landmarks for internal jugular vein catheterization. *Cochrane Database Syst Rev*. 2015; 1. CD006962.
6. Wigmore TJ, Smythe JF, Hacking MB, Raobaikady R, MacCallum NS. Effect of the implementation of NICE guidelines for ultrasound guidance on the complication rates associated with central venous catheter placement in patients presenting for routine surgery in a tertiary referral centre. *Br J Anaesth*. 2007;99(5):662—665.
7. Frykholm P, Pikwer A, Hammarskjold F, et al. Clinical guidelines on central venous catheterisation. Swedish society of anaesthesiology and intensive care medicine. *Acta Anaesthesiol Scand*. 2014;58(5):508—524.
8. Lieberman JA, Williams KA, Rosenberg AL. Optimal head rotation for internal jugular vein cannulation when relying on external landmarks. *Anesth Analg*. 2004;99(4):982—988.
9. Park SY, Kim MJ, Kim MG, et al. Changes in the relationship between the right internal jugular vein and an anatomical landmark after head rotation. *Kor J Anesthesiol*. 2011;61(2): 107—111.
10. Marcus HE, Bonkat E, Dagtekin O, et al. The impact of Trendelenburg position and positive end-expiratory pressure on the internal jugular cross-sectional area. *Anesth Analg*. 2010; 111(2):432—436.
11. Parry G. Trendelenburg position, head elevation and a midline position optimize right internal jugular vein diameter. *Can J Anaesth*. 2004;51(4):379—381.
12. Ozbek S, Apiliogullari S, Erol C, et al. Optimal angle of needle entry for internal jugular vein catheterization with a neutral head position: a CT study. *Ren Fail*. 2013;35(4):492—496.
13. Alderson PJ, Burrows FA, Stemp LI, Holtby HM. Use of ultrasound to evaluate internal jugular vein anatomy and to facilitate central venous cannulation in paediatric patients. *Br J Anaesth*. 1993;70(2):145—148.
14. Ozbek S, Apiliogullari S, Kivrak AS, Kara I, Saltali AO. Relationship between the right internal jugular vein and carotid artery at ipsilateral head rotation. *Ren Fail*. 2013;35(5): 761—765.