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ANATOMICAL VARIATIONS OF THE INTERNAL JUGULAR VEIN: THE ROLE OF ULTRASONOGRAPHY

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SUMMARY

Purpose: In many places, especially in emergency department, central venous catheter is still inserted using anatomical landmark guidance with a success rate up to 97.6% and complications up to 15%. This study was aimed to determine by the support of ultrasonography (US) the anatomical variations of the internal jugular vein (IJV) in relation with other structures of the neck, such as the common carotid artery (CCA).

Material and Methods: 830 patients requiring central vein catheterization (CVC) were included in the analysis. The position of the IJV in relation to the other structures of the neck was demonstrated by portable ultrasonography.

Results: The mean diameter of IJV was 10.3 mm in right and 10.5 mm in left side of neck, in male ($p > 0.05$) and 9.1 mm in right and 10.5 mm in left side of neck, in female ($p > 0.05$). The mean distance between IJV and CCA was 1.9 mm in right and 1.7 mm in left side of neck in male, and 2.0 mm in right and 2.2 mm in left side of neck in female. The mean distance of IJV from the skin surface was 9.8 mm in right and 10.0 mm in left side of neck in male, and 12.1 mm in right and 12.5 mm in left side of neck in female. On 25.54 % we observed variations of internal jugular vein site. On 3.97 % we observed a small caliber of internal jugular vein that could complicate the catheterization of the vein. On 1.8 % was diagnosed a thrombus of internal jugular vein, that is considered as an absolute contraindication for a CVC.

Conclusion: Different patients had anatomical variations that are important and should be knowed, in order to reduce the possibility of severe complications.

Introduction

Central venous catheterization (CVC) is a common procedure used for long term central intravenous therapy, central venous pressure monitoring, dialysis and apheresys (1-3).

The most commonly used technique is percutaneous catheterisation of the internal jugular vein (IJV) which can be found by the identification of an anatomical landmark (Sedillot triangle, formed by medial and lateral heads of the sternocleido-mastoid muscle and base by medial end of the clavicle) (Figure 1), or by Ultrasonography scanning.

The aim of the present paper is to determine the rate of anatomical variations of IJV, in relation with the other structures of the neck, particularly the CCA (4-7), in a cohort of patients who underwent US-guided CVC, in order to underline the importance of anatomical knowledge to reduce the complications related to this procedure, such as difficult or

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failed cannulation, arterial puncture and hematoma, and hemo/pneumothorax (8).

Material and Methods

Between January 1998 and March 2013, in our Unit of General and Thoracic Surgery, we performed US-guided CVC on 830 patients affected by different diseases.

The patients were 456 male and 374 female, the age ranged between 20 and 75 years (mean: 55y.o.).

The IJV and its relationship with other anatomical structures of the neck was identified by a "Prisma-Diasonics" ultrasound instrument with high frequency linear transducer (10 Mhz).

Each patient was placed supine with slight Trendelenburg position, with a 30° neck rotation on contra-lateral side of the procedure. The physician was standing in the same side of the region where to place the catheter. We performed transversal and longitudinal scans on both sides of the neck for each patient, at the Sedillot triangle, at the level of the base of the neck, and we recorded the location of IJV in relation to the CCA (Figure 2) (it was identified as lateral, antero-lateral, anterior, medial, and posterior) and the diameter of IJV and its distance from the skin. Small sized IJV was defined as a diameter ≤5 mm (9). During the catheterization the needle has

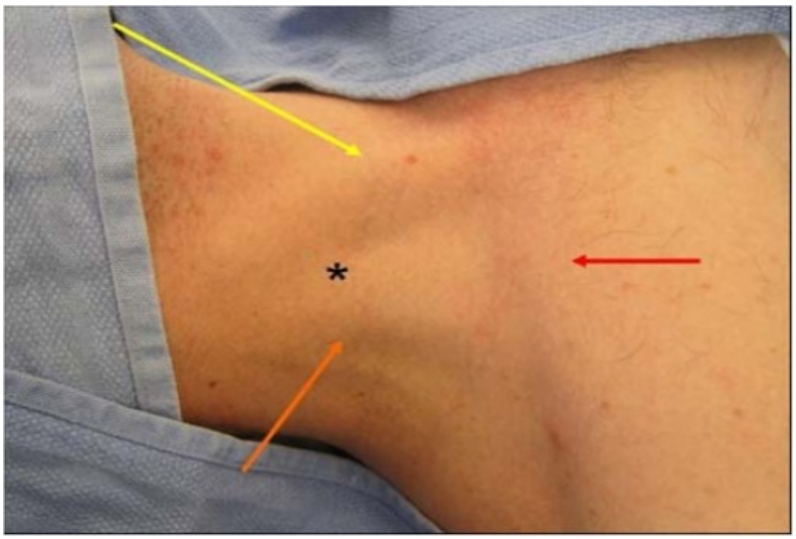

Figure 1: yellow and orange arrows: respectively medial and lateral heads of the sternocleido-mastoid muscle; red arrow: clavicle; star: Sedillot triangle

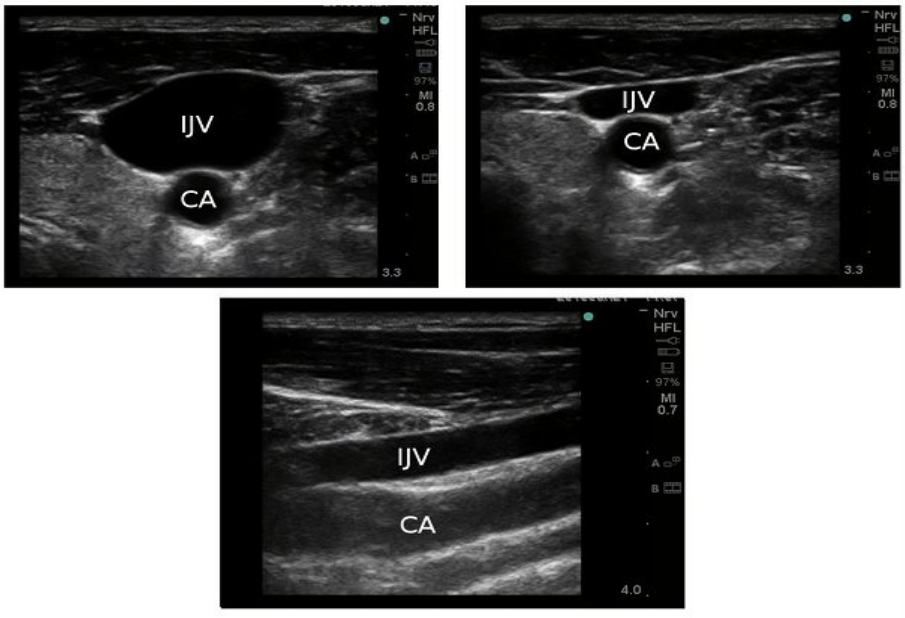

Figure 2: relation between IJV and CA. US guided images

been inserted with an angle of between 30 and 45 degrees. Data were analyzed using Student's T test.

Results

Analyzing the 830 US-guided CVCs we observed:

- the mean diameter of IJV was 10.3 mm in right and 10.5 mm in left side of neck, in male (p>0.05) and 9.1 mm in right and 10.5 mm in left side of neck, in female (p>0.05);
- the mean distance between IJV and CCA was 1.9 mm in right and 1.7 mm in left side of neck in male (p>0.05), and 2.0 mm in right and 2.2 mm in left side of neck in female (p>0.05) (figure 3);
- the mean distance of IJV from the skin surface was 9.8 mm in right and 10.0 mm

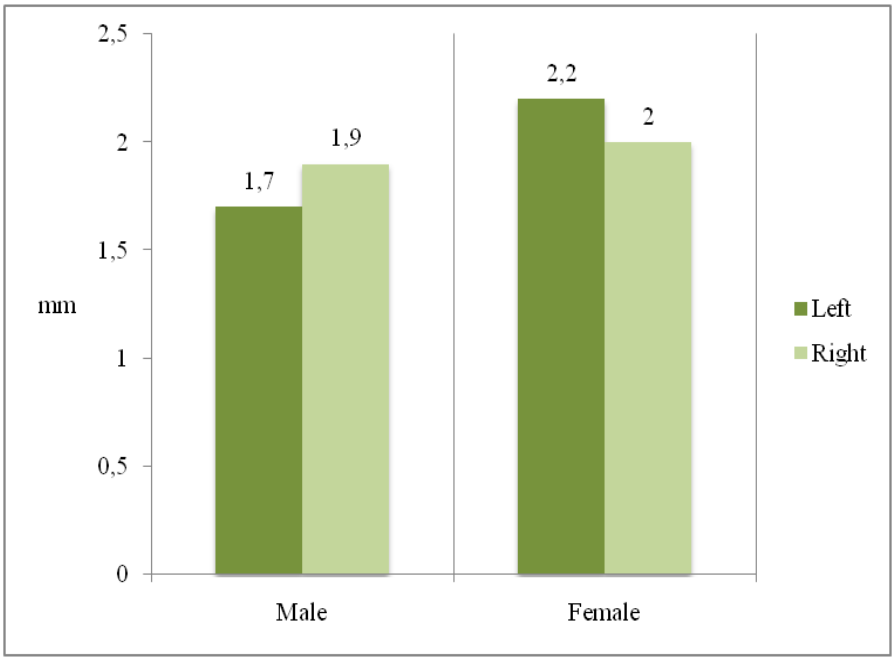

Figure 3: Data about distance between IJV and CCA. Data are expressed in mm

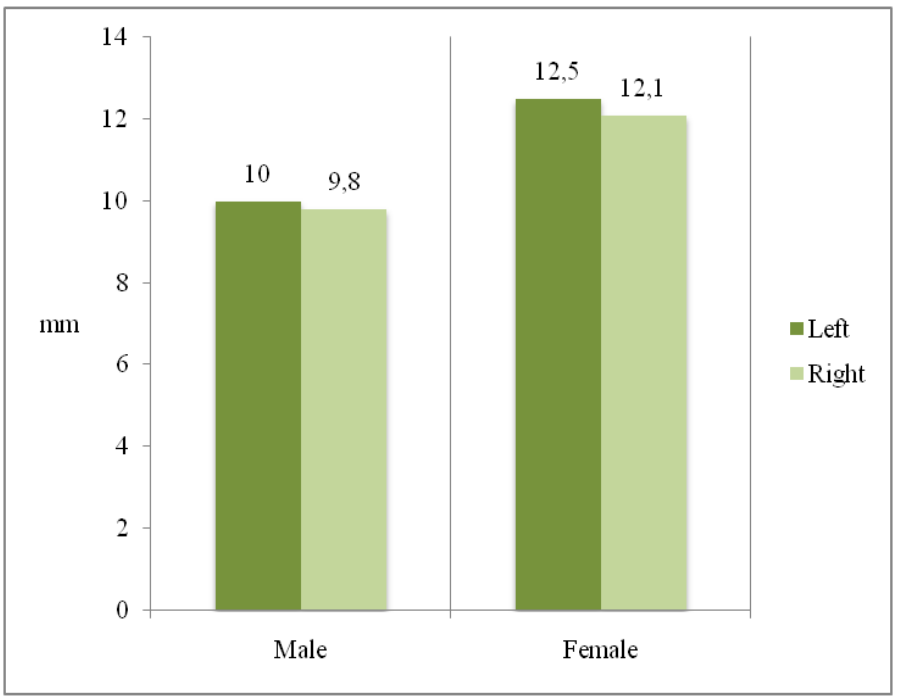

Figure 4: Data about deepth of IJV from the skin surface. Data are expressed in mm

in left side of neck in male (p>0.05), and 12.1 mm in right and 12.5 mm in left side of neck in female (p>0.05) (figure 4);
On 212/830 patients (25.54 %) we observed variations of internal jugular vein site: medialization of the vein 20%, antero-medialization 80% (Figures 5A, 5B; Table 1).
On 33/830 cases (3.97 %) we observed a small caliber of internal jugular vein that could complicate the catheterization (table 2).
On 15/830 cases (1.8 %) was diagnosed a thrombus of internal jugular vein, that is considered as an absolute contraindication for a CVC.
On the remaining 570 (68.67 %) patients no variations of IJV were observed.

Discussion

Usually the IJV is the most superficial and lateral element of the neurovascular bundle (NVB) of the neck and collects the blood from the brain, the superficial part of the face and the neck. It runs down the side of the neck in a vertical direction, lying at first lateral to the internal carotid artery (ICA) and then lateral to the CCA (10). At the root of the neck, the IJV unites with the subclavian vein to form the brachiocephalic vein, direct to the right atrium. The IJV position is almost constant, and this is the reason why it is commonly used for CVC (11).
In previous paper published by our group (12-14) we recorded an average catheterization time of 4 minutes, with 98.7% of

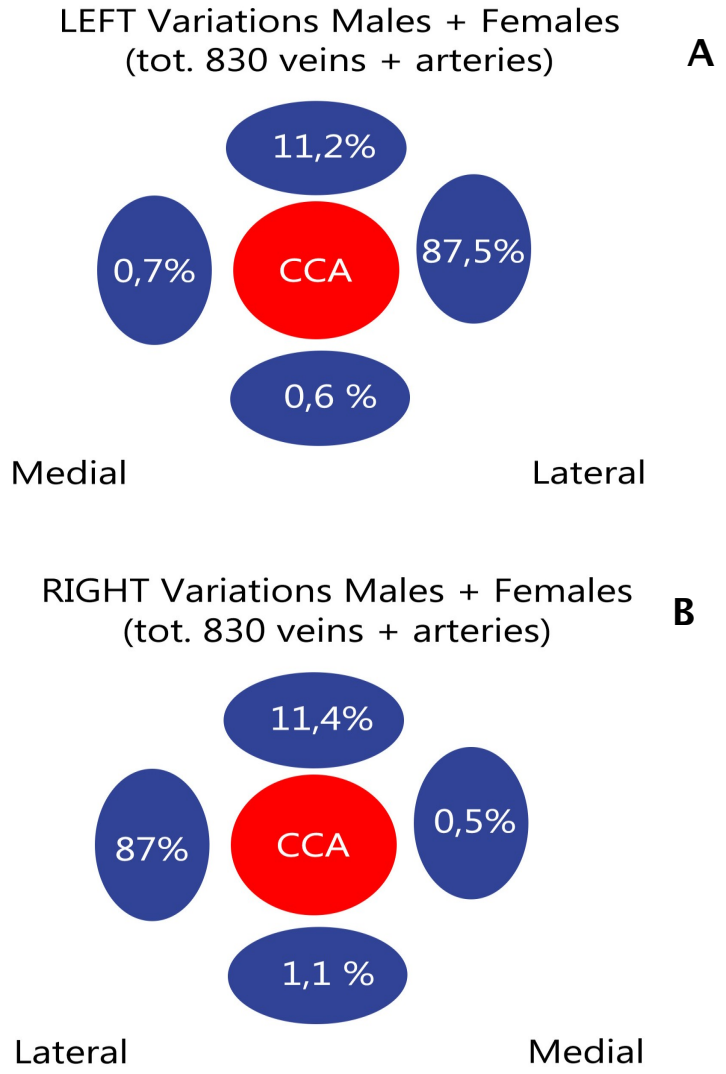

Figure 5: (A) Left variations of the IJV in male and female; (B)Right variations of the IJV in male and female

success rate, 0% of major complications, 4.1% of minor complications such vagal ipotension or catheter dislocation.

However, experienced operators can use different manoeuvres during the procedure to facilitate the access of the IJV, such as rotation of the head, extension of the neck, breath-holding (15), and identification of anatomic landmarks (16) especially in association with ultrasound guidance (17, 18)

In conclusion our study underline the potential problems of catheterization related to the anatomical variations of the IJV; for this reason the knowledge of the anatomy it is crucial for the correct and safe procedure (19-21). The use of ultrasonografy it can be very helpful to improve the anatomical knowledge.

Therefore, according to The American Society of Anesthesiologists Task Force of 2012 (22), and based on our experience (23-27), we can confirm that US-guided procedure may avoid major complications (such as pneumotorax reported in literature) thanks to the precise localization of the anatomical structures, especially helpful in high-risk (27) patients.

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	Male (n: 456)		Female (n: 374)	
	Left	Right	Left	Right
Lateral	401	395	325	327
Anterior	48	54	45	41
Posterior	3	5	2	4
Medial	4	2	2	2

Table 1: Data about position of IJV in relation to CCA

	Male			Female		
	Left	Right	Total	Left	Right	Total
Mean	10.5	10.3	10.4	9.5	9.1	9.3
± SD	1.22	1.26	1.24	1.24	1.18	1.21

Table 2: Data about diameter of IJV. Data are expressed in mm

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