

Anatomical Variants in the Termination of the Cephalic Vein

Stoyan Novakov^{1*}, Elena Krasteva²

¹ Department of Anatomy, Histology and Embryology, ²Department of Propaedeutics of Surgical Diseases, Medical Faculty, Medical University of Plovdiv

* Corresponding author e-mail: stoyan67@gmail.com

Jugulocephalic vein is atavistic structure which is very rare. The low incidence of the variations of the cephalic vein in deltopectoral triangle and its position on the anterior surface of the clavicle and the neck doesn't make it less important for the clinical practice. Phylo- and ontogenesis explain the formation of the above mentioned variations. We followed the pattern of the cephalic vein in its proximal part and termination to describe possible variations. In this long term study on 140 upper limbs of 70 cadavers, 4 or 2,9% of the cephalic veins were variable. The direct emptying of the cephalic vein into internal jugular is an exception with few descriptions at the moment. The rareness of this anatomical variation doesn't make it less important for clinical practice. It is described as a possible obstacle in catheter implantation, clavicle fractures and creation of arteriovenous fistula in patients on hemodialysis.

Key words: cadavers, human anatomy variation, cephalic vein, external jugular vein, jugulocephalic vein

Introduction

Cephalic vein (CV) belongs to the group of superficial veins of the upper limb. It usually forms over the anatomical snuff-box on the radial side of the wrist from the radial end of the dorsal venous plexus. Proximally it curves around the lateral side of the forearm collecting tributaries from both radial and ulnar aspects in that area. The CV ascends anterior to the elbow, superficial to a groove between brachioradialis and biceps brachii, crosses superficial to the lateral cutaneous nerve of the forearm, and ascends lateral to biceps and between pectoralis major and deltoid, where it adjoins the deltoid branch of the thoracoacromial artery [15]. At the lateral aspect of the deltopectoral groove, the CV is located superficially in a fat pad lying horizontally and separating the two muscles [7]. In the infraclavicular fossa it passes posterior to pectoralis major and piercing the clavipectoral fascia it crosses the axillary artery and opens in the axillary vein at the level of the lower border of the clavicle [15].

Variations of cephalic vein are rare. They include its total absence and termination into subclavian vein [14]. The cephalic vein may end in the internal jugular vein (IJV), the external jugular vein (EJV), or the basilic vein [6, 12]. A more infrequent anastomosis named "jugulocephalic anastomosis", which usually connects the terminal part of the cephalic and

the EJV, appears where cephalic vein goes deep behind the clavicular head of pectoralis major and travels up anterior to the clavicle [12, 17].

The very first thorough description in anatomy by Galen defines cephalic vein (Galen's humeral vein) as arising from the external jugular vein and encircling the clavicle 'ran towards the periphery' [19]. That postulate like all other Galen's anatomy beliefs rules for centuries. The explanation for this misleading information is in the material of his dissection which is animals and non-human primates [16]. So we can define the jugulocephalic vein like an atavistic feature in humans. Phylogenetic and ontogenetic features of the superficial veins of the neck and upper limbs are clarifying the possible anatomical variants found rarely but not meaninglessly.

Study of variations in the superficial veins is important for the anatomists, interventional radiologists, surgeons, and clinical practitioners who carry out procedures like canulations, venegraft harvesting in endarterectomy, implantation and selective venous samplings, as well as traumatologists, plastic surgeons and specialists in centers for hemodialysis [2,9, 14].

The aim of this study was to follow up the incidence of CV variations in its termination and discuss the embryological basis and clinical implications.

Material and methods

During a routine gross anatomy dissection in the Department of Anatomy, Histology and Embryology at the Medical Faculty, Medical University of Plovdiv we made observation for the termination of CV on 140 upper limbs of 70 (52 men and 18 women) embalmed cadavers for a period of 18 years.

Results

Four out of 140 upper limbs showed significant differences from the usual pattern of the CV in its most proximal part.

Case No 1. – An adult male cadaver aged approximately 75 years dissected for educational purposes showed two concomitant variations in the left axilla and on the same side of the neck. The axillary arch of Langer was more common one but the CV draining in EJV was really a rare variety. The vein travelled in the deltopectoral groove and remained superficial after reaching the clavicle where it passed anterior to it. Arching the clavicle the CV after a short course entered the EJV at its terminal part. Its supraclavicular part was 12 mm long. No anastomoses or extra tributaries were found coming out from the CV in the observed area (**Fig.1**).

Case No 2. – During the dissection of an adult male cadaver over age of 70 another variation in the course and position of the terminal part of the left CV was found. At the level of the coracoid process CV divides into a main tributary which arches deep under the pectoralis major muscle to join axillary vein and so called 'jugulocephalic anastomosis' climbing on the anterior surface of the clavicle to the adjacent EJV (**Fig.2**).

Case No 3. – The last case was male cadaver aged 62 years. He was the most recently dissected and with multiple variations. The followed cephalic vein pattern was different on both sides from the standard described in the books.

On the right side CV was positioned lateral out of the deltopectoral groove following the fibers of the deltoid muscle. In the distal portion of the deltoid the CV was 1 cm lateral of its border. It travelled up and medial and crossed the clavicle at the attachment of the medial edge of deltoid muscle. In fossa supraclavicularis major CV received a tributary coming from the fossa supraclavicularis minor which is following the upper border of the clavicle.

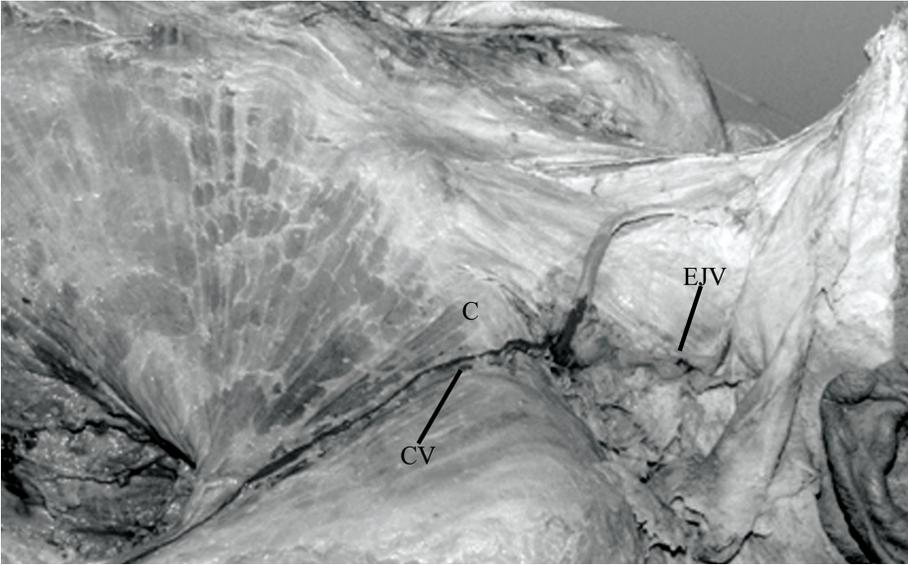


Fig. 1. Left arm, shoulder and neck with cephalic and external jugular veins.
EJV – external jugular vein, CV – cephalic vein, C - clavicle



Fig. 2. Left arm, shoulder and neck with cephalic and external jugular veins.
EJV – external jugular vein, CV – cephalic vein, C – clavicle, * - jugulocephalic anastomosis

The main vein continued deep under the sternocleidomastoid to enter the lateral side of the internal jugular vein. The length of the CV from the distal end of deltopectoral groove to IJV was 183 mm. The length from the point of entry to the right venous angle was 59 mm and to the upper end of the superior vena cava it was 95 mm. The diameter of the CV at its end was 5 mm (**Fig. 3**).

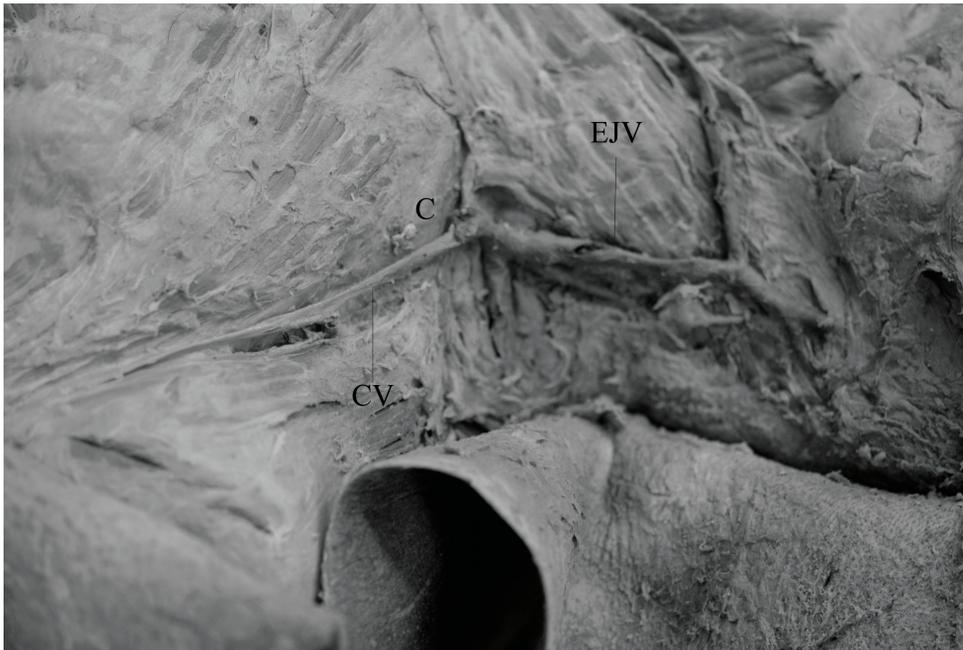


Fig. 3. Left deltopectoral groove and neck.
EJV – external jugular vein, CV – cephalic vein, C – clavicle

The left CV was lying in the deltopectoral groove. Its length from the distal beginning of the groove to the entry into EJV was 149 mm. There were no tributaries to CV in this region. It was crossing anterior the clavicle and medial to the attachment of deltoid. Finally CV entered the EJV (**Fig. 4**).

A concomitant variation related to the thyroid gland was found on the neck of the last case.

The incidence of the variations of the CV, crossing the anterior aspect of the clavicle, is 2,9% of the population in Bulgaria. The incidence of jugulocephalic anastomosis is 0,7%.

Discussion

The cephalic vein is one of the most used veins for a great number of activities, such as venipunctures, arteriovenous fistula creation and for right atrial and ventricular lead placement in patients receiving pacemakers and implantable cardioverter defibrillators [1, 18]. CV is usually anatomical landmark known for its consistent anatomy because of its rare variability. Despite that, its anatomical variations are clinically and surgically significant and healthcare professionals must be aware of the variations of this vessel [1].



Fig. 4. Right deltopectoral groove and neck.
CV – cephalic vein, C – clavicle, IJV – internal jugular vein

In this article we present some exceptional variations of CV which are considered atavistic and explained by the onto- and phylogenetic development. The superficial veins of the upper limb develop from a superficial plexus of capillaries, then, as they fuse and enlarge, the greater venous trunks are formed. The capillary plexus on the ulnar border develops the subclavian, axillary and basilic veins which emerge from the postaxial primitive vein. The radial border capillary plexus atrophies and CV at further stages of development comes from the preaxial vein [1, 16]. The preaxial vein primarily empties into the venous plexus located within the neck [19]. The CV is developed by a growth of an anastomotic channel of the EJV which initially empties into the IJV and later into the axillary vein [8, 13]. Thus, the CV acquires a new connection with the axillary vein only at a further stage of the ontogeny, while, usually, the part of the CV running over the clavicle (the jugulocephalic vein) gradually atrophies [19]. In our study three of the vessels are persistent jugulocephalic vein which in case No2 occurs as a connecting branch between EJV and CV that normally ends in the axillary vein or it is a typical jugulocephalic anastomosis, while in cases No1 and No3 (left side) the remnant jugulocephalic channel connects directly CV to EJV.

The right CV of the case No 3 is a very rare variation which could be explained by the ontogeny of the superficial veins and a stage of existing connection between CV and IJV. We found just one more case in the available literature which described that unusual end of CV into IJV [8].

The cephalic vein has recently emerged as an alternative to the subclavian and EJVs for the implantation of catheters and artificial cardiac pacemakers [5]. CV cut-down is considered a first choice for venous access [3]. Although variations of CV are rare they should be taken in mind during these manipulations as they can cause some

difficulties [3]. In cases of central venous line insertion that requires critical central venous access from the subclavian vein, the CV cut-down method is employed at the deltopectoral to insert a catheter under visual inspection [10]. Clinically, the CV is preferred for hemodialysis to remove waste products from the blood [9]. The variant anatomy of the cephalic arch is important for arteriovenous fistula creation in patients on hemodialysis and the clinicians caring for vascular access patients may choose to consider alternative vascular access [4]. Orthopedicians treating fractures of the clavicle by either percutaneous intramedullary nailing or open exposure should be very careful to avoid potentially iatrogenic injuries for the patient from an unnoticed anatomic variant [11].

Human anatomy variations are abundantly described in the literature but are not yet well systematized and categorized. Kameda et al. are classifying the CV variations in the deltopectoral region into four types: 1A, 1B, 2A, and 2B [5]. Two of our CVs are Type 1A, one is 1B and the rare case of CV emptying in IJV is not included in Kameda's classification. We agree that more studies in the future are needed to evaluate both arms with a larger pool of cadavers and confirm the incidence of unusual jugulocephalic veins and CV termination [5].

Conclusion

Based on the result of 140 upper limbs of 70 embalmed cadavers, from our study 3 out of 70 (4,3%) cadavers are with CV variations, one bilateral and two unilateral on the left side. Four out of 140 (2,9%) cephalic veins pass anterior to the clavicle and follow a course beyond this bone. One CV or 0,7% is registered as jugulocephalic anastomosis and 1 (0,7%) CV terminates in IJV. Knowledge of these anatomical variants could avoid serious complications during catheter implantation, fractures of the clavicle or arteriovenous fistula creation in patients on hemodialysis.

References

1. Araújo, R. C., L. A. S. Pires, M. L. Andrade, M. C. Perez, C. S. L. Filho, M. A. Babinski. Embryological and comparative description of the cephalic vein joining the external jugular vein: A case report. – *Morphologie*, **102**, 2018, 44-47.
2. Darabi, M. R., A. Shams, P. Bayat, M. Bayat, S. Babae, B. Ghahremani. A Case report: variation of the cephalic and external jugular veins. – *ASJ*, **12**, 2015, 203-205.
3. De Maria, E, S.Cappelli. Cephalic vein with a supraclavicular course: rare, but do not forget it exists! – *J. Cardiovasc. Med. (Hagerstown)*, **18**, 2017, 727-728.
4. Jun, E. S. W., A. L. Y. Lun, M. Nikam. A rare anatomic variant of a single-conduit supraclavicular cephalic arch draining into the external jugular vein presenting with recurrent arteriovenous fistula stenosis in a hemodialysis patient. – *J. Vasc. Surg. Cases Innov. Tech.*, **22**, 2017, 20-22.
5. Kameda, S., O. Tanaka, H. Terayama, T. Kanazawa, R. Sakamoto, S. Tetsu, K. Sakabe. Variations of the cephalic vein anterior to the clavicle in humans. – *Folia Morphol. (Warsz)*, 2018 in press
6. Komanda, R. K. S., M. Asif, C. H. Shivarama. Supraclavicular course of the left cephalic vein: Rare anatomical variant. – *Int. J. Case Rep. Images*, **8**, 2017, 792–795.
7. Loukas, M., C. S. Myers, C. T. Wartmann, R. S. Tubbs, T. Judge, B. Curry, R. Jordan. The clinical anatomy of the cephalic vein in the deltopectoral triangle. – *Folia Morphol. (Warsz)*, **67**, 2008, 72-77.
8. Lum, C., E. D. Ladenheim. An interesting clinical case: variant of the cephalic vein emptying into the internal jugular vein. – *Seminars in Dialysis*, **26**, 2013, E11-E12.
9. Maalman, R. S., Y. O. Donkor, A. M. Ayamba, J. K. Abledu. A Rare anatomical variation of the termination of right and left cephalic veins. – *Case Rep. Vasc. Med.*, **2018**, 2018, 1.

10. **Parsonnet, V., M.Roelke.** The cephalic vein cutdown versus subclavian puncture for pacemaker/ ICD lead implantation. – *Pacing Clin. Electrophysiol.*, **22**, 1999, 695-697.
11. **Ramírez, J. D., L. C. Sáenz, D. Rodríguez, A. J. Restrepo, F. Villegas.** Supraclavicular course of the cephalic vein. – *Int. J. Case Rep. Images*, **5**, 2014, 281–284.
12. **Saaid, A., I. Drysdale.** Unusual termination of the cephalic vein. – *Clin. Anat.*, **21**, 2008, 786-787.
13. **Schoenwolf, G. C., S. B. Bleyl, P. R. Brauer, P. H. Francis-West.** *Larsen's human embryology.* Churchill Livingstone, 2014.
14. **Shetty, P., S. B. Nayak, R. Thangarajan, M. R. D'Souza.** A rare case of persistent jugulocephalic vein and its clinical implication. – *Anat. Cell Biol.*, **49**, 2006, 210-212.
15. **Standring, S.** *Gray's Anatomy: The Anatomical Basis of Clinical Practice*, Elsevier; 41 edition, 2016, 830.
16. **Thiranagama, R., A. T. Chamberlain, B. A. Wood.** *The comparative anatomy of the forelimb veins of primates.* – *J. Anat.*, **164**, 1989, 131-144.
17. **Tubbs, R. S., M. M. Shoja, M. Loukas.** *Bergman's Comprehensive Encyclopedia of Human Anatomic Variation*, Wiley-Blackwell; 1 edition, 2016, 829-830.
18. **Watts, T. E., S. Pant, S. Reddy, K. Siddiqui, D. Singh, H. Paydak.** Cephalic vein cutdown for left ventricular lead placement in biventricular device upgrades. – *J. Innov. Cardiac Rhythm Manage.*, **6**, 2015, 1906-1907.
19. **Wysiadecki, G., M. Polgaj, M. Topol.** Persistent jugulocephalic vein: case report including commentaries on distribution of valves, blood flow direction and embryology. – *Folia Morphol. (Warsz.)*, **75**, 2016, 72-77.