Int. J. Morphol.,
42(6):1700-1705, 2024.

Anatomical Variations of Venous Patterns in the Dorsum of the Hand and Beginning of the Cephalic Vein in Live Sudanese

Variaciones Anatómicas de los Patrones Venosos en el Dorso de la Mano e Inicio de la Vena Cefálica en Sudaneses Vivos

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ELGHAZALY A. E. Anatomical variations of venous patterns in the dorsum of the hand and beginning of the cephalic vein in live Sudanese. *Int. J. Morphol., 42(6)*:1700-1705, 2024.

SUMMARY: Detailed anatomical knowledge of the dorsal hand veins and the beginning of the cephalic vein (CV) will help ensure safe venipuncture in many clinical applications. This study aims to evaluate the anatomical variation of venous patterns on the dorsum of the hand, the beginning of the CV, and its relationship to the radial styloid process in living Sudanese. The dorsal metacarpal veins (DMVs) of the hand and the beginning of the CV were studied in 440 healthy hands, 240 (54.5 %) males and 200 (45.5 %) females, between January and April 2024, using a tourniquet and a digital camera. Two methods were adopted to identify venous patterns, the course of most visible DMVs, and the communications between them. Five different types of venous patterns were observed; the most common pattern was type III (34 %) followed by type II (29.5 %), while type VI (2.5 %) was less observed. There were no statistical differences between venous patterns and sex or between the right and left sides of the body sides, ($p>0.05$. In (45.3 %) of males and (46.2 %) of females, the CV was found begins at the confluence of the first dorsal metacarpal vein with the second. In (76.6 %) of males (and 78.5 %) of females, the CV was found runs posterior to the radial styloid process. The second and third DMVs have participated in the formation of most venous patterns. The union of the first with second DMVs considered the best point for determining the beginning of CV. A higher incidence of CV location posterior to the radial styloid process is considered a suitable point to find this vein during venipuncture.

KEY WORDS: Anatomical variations; Venous pattern; Dorsum of the hand.

INTRODUCTION

Upper limb veins are the first choice for venipuncture in many clinical practices. The dorsal veins of the hand and the beginning of the cephalic vein (CV) are considered a major component of health care for patients and medical staff. Venipuncture of these veins seems simple, but needs good anatomical knowledge (Salameh *et al*., 2019; Mukai *et al*., 2020).

Venous blood from the upper limb is returned to the heart through two groups, venous deep and superficial. The deep groups found under the deep fascia and run closely related to the arteries, while the superficial groups are found under the skin. The superficial venous groups of the upper limbs are variable in number, position, connection, and pattern (Moore *et al*., 2018; Snell, 2019). The superficial venous groups of the upper limbs use for various clinical purposes such as venipuncture, transfusion, and cardiac catheterization, (Matsuo *et al*., 2017; Standring, 2020). The main superficial venous groups of the upper limb which are used for clinical practice, are the dorsal hand veins, cephalic, basilic, and median cubital veins (Matsuo *et al*., 2017; Elmegarhi *et al*., 2018; Standring, 2020).

The dorsal veins of the hand are a group of superficial veins that lie in subcutaneous tissues on the dorsal aspects of the metacarpal bones (Kurita *et al*., 2015; Tiwari *et al*., 2019; Standring, 2020). The dorsal hand veins (DMV) are formed at the distal ends of the metacarpal bones by connections of the digital dorsal veins of the fingers. In most cases, these veins connect with each other, forming various patterns in the dorsal aspect of the hand (Kameda *et al*., 2018). The dorsal hand veins then drain into the cephalic and basilic veins (Tiwari *et al*., 2019; Lee *et al*., 2019).

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Received: 2024-06-15 Accepted: 2024-07-26

The CV is arises from the lateral aspect of the dorsal veins of the hand, then ascends upward in the subcutaneous tissue proceeding along the lateral margin of the wrist, behind the radial styloid process, is longitudinally on the lateral margin of the forearm, in the arm between the deltoid and the major muscles of the pectoralis along the deltopectoral groove, then enters the clavipectoral triangle, pierces the deep fascia to join the upper part of the axillary vein below the clavicle (Vialle *et al*., 2001; Yeri *et al*., 2009; Moore *et al*., 2018; Salameh *et al*., 2021). At elbow level, the CV communicates with the median cubital vein (Cerda & del Sol, 2015; Kameda *et al*., 2018). CV drains the venous blood of the lateral parts of the hand, forearm and arm and communicates along its course with the basilic vein (Matsuo *et al*., 2017; Sadeghi *et al*., 2017). It is often visible under the skin throughout its course and runs constantly beyond the styloid process of the radius in most people (Moore *et al*., 2018; Standring, 2020).

In many clinical practices, dorsal hand veins and the beginning of CV are commonly the choice for venipuncture (Pires *et al*., 2019; Mukai *et al*., 2020). Several studies have shed light on these veins in different populations, but still there is little information about their anatomical variations; therefore, detailed anatomical information about these veins, will help ensure safe venipuncture in many clinical applications. Therefore, the anatomical variations of the venous patterns of the dorsal hand veins, the beginning of the CV, and its relations to the radial styloid process were studied in live Sudanese: for performing safe venipuncture.

MATERIAL AND METHOD

This cross-sectional observational study was conducted between January and April 2023, in Khartoum States, Sudan, in 220 healthy volunteer adult Sudanese participants, their ages ranged between 20 to 80 years old. The procedures were performed in both hands and the distal part of the forearm, at room temperature and in good light, using a tourniquet and a digital camera. A total number of 260 hands, 130 men and 100 women were examined. Hands with injuries, scars, burns, edematous, and infections were excluded. Participants were informed in detail about the procedure and signed written consent.

Procedures: Participants were placed in a comfortable and relaxing position. The hands were placed in a prone position on a flat table and exposed. The tourniquet was applied about 3 to 4 centimeters above to the radial styloid process and tied enough to occlude the veins, but allowed arterial blood to pass to the hand. When the veins became visible, their courses were traced in the metacarpal spaces and then classified into five main groups based on their connections as follows:

- Type I: the dorsal hand veins were found to be connected to form a network-shaped venous pattern.
- Type II: The dorsal hand veins were found to be connected to form a W-shaped venous pattern.
- Type III: the dorsal hand veins were found to be connected to form a C- or curve-shaped venous pattern.
- Type IV: the dorsal hand veins were found to be connected to form an H-shaped venous pattern.
- Type V: the dorsal hand veins were found to be connected to form a Y-shaped venous pattern
- Type VI: the dorsal hand veins were found to be connected to form a tree-shaped venous pattern.

The beginning of the CV and its relation to the styloid process of the radius were also observed. The photos were then taken about 1 to 2 minutes after the tourniquet application, using a mobile phone camera. Images were carefully analyzed and grouped according to the vein pattern observed. Data Analysis: Data were analyzed using SSPS16 software, and frequencies, percentages, and P-values were taken.

RESULTS

The participants included in this study were 220 adult volunteer Sudanese subjects, aged 20 to 70 years (mean age, 31.7 ± 2.13 standard deviation), of whom, 120 (54.5 %) were men and 100 (45.5 %) were women. Out of all 440 examined hands, 240 (54.5 %) were males, and 200 (45.5 %) were females. Four hundred hands were included, 214 (58.6 %) were males and 186 (42.4 %) were females. Forty hands were excluded, 26 (5.9 %) were males and 14 (3.2 %) were females, due to complex patterns, small size or unclear veins (Table I). Of all included hands, 192 (48.0 %) were right and 208 (52.0 %) were left. (Table I).

Table I. Numbers and frequencies of the hands of both sexes.

Characteristics		No. of subjects (%)	Number of examined hands (%)	No. of hands included (%)	Number of excluded hands (%)
Sex	Male	120 (54.5 %)	240 (54.5 %)	214 (58.6 %)	26 (5.9 %)
	Female	100 (45.5 %)	200 (45.5 %)	186 (42.4 %)	14 (3.2 %)
Total		220 (100 %)	440 (100 %)	400 (90.9 %)	40 (9.1 %)
Hand	Right		220 (50.0 %)	192 (48.0 %)	
	Left		220 (50.0 %)	208 (52.0 %)	
Total			440 (100 %)	400 (100 %)	

It was found during the observation of the dorsal aspect of the hand that the veins showed different patterns. Type I was found in 28 (13.1 %) males and 26 (14.0 %) females; in this type, the second, third, and fourth DMVs are connected by different intravenous connections that form a venous pattern in the form of a network, in the dorsal aspect of the hand (Fig. 1A). Type II was found in 64 (29.9 %) males and 54 (29.0 %) females, in this type, the second, third, and fourth DMVs were connected, forming a venous pattern in the form of a W-shaped, on the dorsal aspect of the hand (Fig. 1B). Type III was found in 76 (35.5 %) males and 60 (32.3 %) females, in this type, the second and third DMVs were connected, forming a venous pattern in the form of a C-shaped or arch, on the dorsum of the hand (Fig. 1 C). Type IV represented 30 (14.0 %) males and 22 (11.8 %) females, in this type, the second and third DMVs were connected by a transverse vein that forms a venous pattern in the form of H, in the dorsal aspect of the hand (Fig. 1 D). Type V represented 12 (5.6 %) males and 18 (9.7 %) females, in this type, the second and third DMVs were connected at the level of the wrist, forming a venous pattern in the form of a Y-shaped, on the dorsum of the hand (Fig. 1 E). Type VI was the least common, found in 4 (1.9 %) males and 6 (3.2 %) females, in this type, the second, third, and fourth DMVs were connected with the dorsal metacarpal vein forming a venous pattern in the form of a Tree shaped on the dorsal aspect of the hand (Fig. 1F). During observation of the DMVs on the dorsal aspect of the hand, the most visible veins were the second and third.

In males, the most common venous patterns observed were Type III (35.5 %) followed by Type II (29.9 %), while Types I, IV and V were (13.1 %, 14.0 %, and 5.6 %) respectively, and Type VI (1.9 %) was less observed. In women, the most observed patterns were type III (32.3 %) followed by type II (29.0 %), while type I, IV, and V were (14.0 %, 11.8 %, and 9.7 %) respectively, type VI (3.2 %) was less observed. Regarding the body side, type III (33.3 %) and type IV (31.3 %) were more observed in the right hand, type I (33.8 %) and type V (36.5 %) were more observed in the left hand, while type VI was less observed in both hands (1.0 %) (Table II). There were no statistical differences between venous patterns and sex or the sides of the right and left body sides, ($p>0.05$) (Table II).

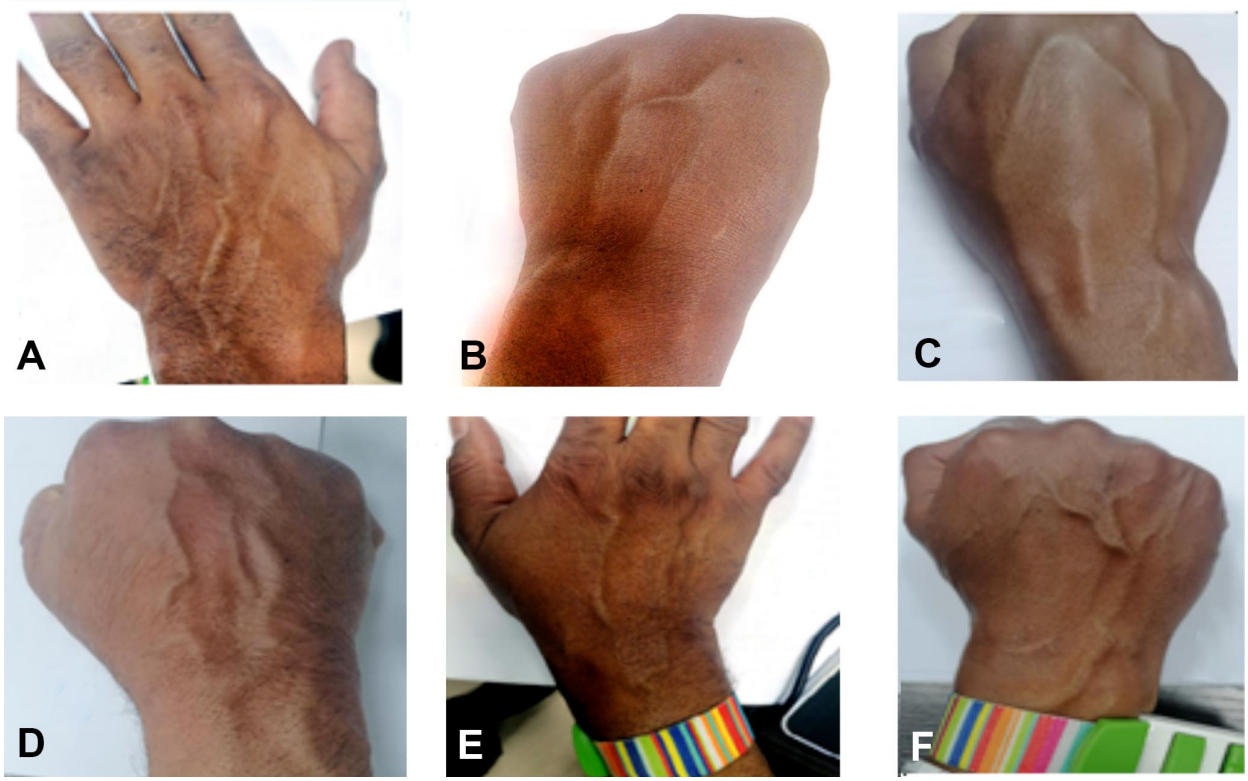

Fig. 1. Photographs of the dorsum of the hand, showing different superficial venous patterns of the hand. (A) Left-hand hand shows DMVs run randomly forming a network-shaped venous pattern on the dorsal aspect of the hand. (B) Left-hand shows the second, third, and fourth DMVs connected, forming a W-shaped venous pattern on the dorsal aspect of the hand. (C) The right hand shows the second and 4th DMVs connected, forming a C-shaped venous pattern on the dorsal aspect of the hand. (D) Right hand shows the second and fourth DMVs connected, forming an H-shaped venous pattern on the dorsal aspect of the hand. (E) Right hand shows the second and 4th DMVs connected forming a Y-shaped venous pattern on the dorsal aspect of the hand. (F) Right hand shows the 2nd, 3rd, and 4th DMVs connected, forming a tree-shaped venous pattern on the dorsal aspect of the hand.

Table II. Patterns of dorsal hand veins in both sexes (N= 400 hands).

Characteristics		Patterns of dorsal hand veins (Frequency & Percentage)							
		Type I	Type II	Type III	Type IV	Type V	Type VI	Total	P-value
Sex	Male	28(13.1 %)	64(29.9 %)	76(35.5 %)	30(14.0 %)	12(5.6 %)	4(1.9 %)	214(100 %)	0.3012
	Female	26(14.0 %)	54(29.0 %)	60(32.3 %)	22(11.8 %)	18(9.7 %)	6(3.2 %)	186(100 %)	
Body side	Right hand	24(12.5 %)	14(7.3 %)	64(33.3 %)	60(31.3 %)	28(14.6 %)	2(1.0 %)	192(100 %)	0.1501
	Left hand	70(33.8 %)	22(10.5 %)	22(10.5 %)	16(7.7 %)	76(36.5 %)	2(1.0 %)	208(100 %)	

The beginning of CV was found in both sexes, in (5.6 %) of males and (9.8 %) of females from the lateral limb of the dorsal venous arch of the hand (Fig. A2, Table III), in (29.4 %) of males and (21.5 %) of females from the first dorsal metacarpal vein (Fig. B1), in (15.9 %) of males and (18.3 %) of females from the second dorsal metacarpal vein, in (45.3 %) of males and (46.2 %) of females from the connection of the first with the DMV (Fig. A1), in (3.7 %) of males and (4.3 %) of females from the connection of the second with the third DMV (Fig. B2). The relationship of CV to the styloid process of the radius of the radius was found in both sexes, (76.6 %) of males, (78.5 %) of females, posterior to the styloid process (Figs. A1, 2), (23.4 %) of males, (21.5 %) of females on the laterally to styloid process (Figs. B1, 2), but CV was not found to pass anterior to the styloid of the radius in males or females.

Table III. Cephalic vein, beginning and location to the radial styloid process (N= 400 hands).

Characteristics	Variations	Males (No. & %)	Females (No. & %)
beginning of the cephalic vein	From the lateral limb of the dorsal venous arch	12 (5.6 %)	18 (9.8 %)
	From the first dorsal metacarpal vein	63 (29.5 %)	40 (21.5 %)
	From the second dorsal metacarpal vein	34 (15.9 %)	34 (18.3 %)
	From the connection of the first with the second DMVs	97 (45.3 %)	86 (46.2 %)
	From the connection of the second and third DMVs	8 (3.7 %)	8 (4.3 %)
Total		214 (100 %)	186 (100 %)
Location of the cephalic vein to radial styloid process	Posterior to the styloid process	164 (76.6 %)	146 (78.5 %)
	On the lateral aspect of the styloid process	50 (23.4 %)	40 (21.5 %)
	Anterior to the styloid process	00 (0.0 %)	00 (0.0 %)
Total		214 (100 %)	186 (100 %)

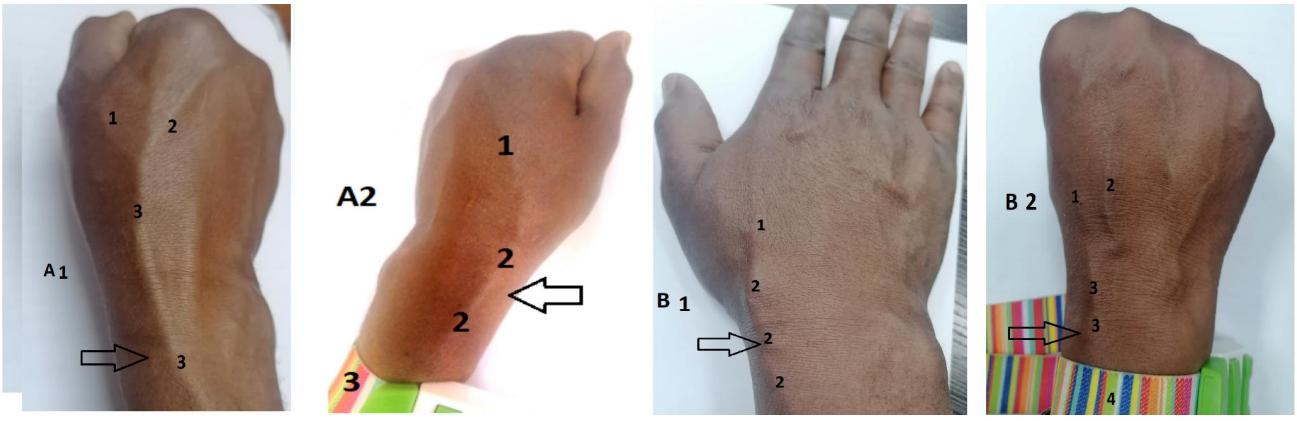

Fig. 2. Photographs in the dorsum of the hand and wrist region show the origin of the CV and its relation to the radial styloid process, a row shows radial styloid process. (A1) Right hand shows the CV begins from the connection of the first with second DMVs, 1- first dorsal metacarpal vein, 2- second dorsal metacarpal vein, 3- CV passes behind to radial styloid process. (A2) The left hand shows CV begins from the proximal end of the second dorsal metacarpal vein, 1- second dorsal metacarpal vein, 2- CV passes behind to radial styloid process, 3- tourniquet. (B1) Right hand shows CV begins from the proximal end of the first dorsal metacarpal vein, 1- first dorsal metacarpal vein, 2- CV passes on the lateral aspect of radial styloid process. (B2) the right hand shows CV begins from connection of the first with second DMVs, 1- first dorsal metacarpal vein, 2- second dorsal metacarpal vein, 3- CV passes on the lateral aspect of radial styloid process, 4- tourniquet.

DISCUSSION

The current study adopted two methods to identify venous patterns in the dorsal aspect of the hand, the course of visible DMV, and communications between them. Five different types of venous patterns were found during observations of the dorsal aspect of the hand. The most common pattern in both sexes was type III (34 %) followed by type II (29.5 %), while type VI (2.5 %) was less observed. This finding is consistent with recent studies that found that DMVs were classified into different anatomical patterns instead of being considered a network of veins (Elmegarhi *et al*., 2018; Salameh *et al*., 2019). Two of the venous patterns described in the current study were very rare (type V and VI). In type V the DMVs were connected, forming a Y-shaped venous pattern on the dorsal aspect of the hand, and in type VI, the DMVs were connected, forming a tree-shaped venous pattern on the dorsal aspect of the hand. To our knowledge, these patterns have not been described before, and it should be mentioned that they could have been a rare phenomenon among the upper limb veins. Naturally, the superficial veins are connected to form different venous patterns, ranging from simple to complex. Therefore, whatever pattern, good anatomical knowledge is required for a successful venipuncture. There were no statistical differences between venous patterns and sex or between the right and left sides of the sides of the body sides, ($p>0.05$).

The present study found that the most visible DMVs in the dorsal aspect of the hand were the second and third, these veins run in a semi-straight course, have little communication with other veins, and are involved in forming most venous patterns. While, the study by Salameh *et al*. (2019) found that the most visible DMVs were the third and fourth in both hands and sexes. Our findings are inconsistent with those of Muna, Muna used an infrared vein illumination system to identify DMVs, while the present study used visual observation to study the DMVs. Visual observation is one of the best methods for identifying the superficial veins. The findings in our study clearly showed that whatever the venous pattern, there are predominantly two or three DMVs that play an important role in the formation of the venous pattern. Therefore, the identification of the visible DMVs of the hand helps in the determination of venous patterns. Thus, recognizing the course of the most visible DMVs in the dorsal aspect of the hand, whether studied individually or through different venous patterns, is important for safe venipuncture during clinical practices.

Identification of the beginning of the CV is an important issue in clinical practice because it is one of the upper limbs veins most commonly used in venipuncture. The study by Vialle *et al*. (2001) reported that CV usually arises from the superficial dorsal vein of the thumb, while Matsuo *et al*. (2017) found that CV consistently begins from a collateral vein of the deep palmar arch. In the current study CV it was found to arise from the connection of the first and second DMV in (45.3 %) of men, (46.2 %) of women and from the first dorsal metacarpal vein in (29.5 %) of men, (21.5 %) of women in most cases. The findings in this study are consistent with most of the information in anatomical textbooks (Moore *et al*., 2018; Standring, 2020), and the study of Salameh *et al*. (2019), in which they stated that the first and second metacarpal veins were frequently involved in CV formation. This confirms that CV commonly arises from the distal part of the first dorsal metacarpal vein or the form connection of the first with the second DMV. Thus, the venous union of the first and second DMVs considered the best anatomical landmark for the beginning of the CV. These suggest that CV is the main vein that is constantly located on the lateral side of the wrist region and serves as the main drainage of blood from the radial side of the hand and provides a reliable venipuncture site in this region.

The present study also described the course of the CV in the radial styloid process. Two main relations have been demonstrated. One described the course of the CV posterior radial styloid process in (76.6 %) males and (78.5 %) females, the other described the course of the CV lateral radial styloid process in (23.4 %) males and (21.5 %) females. The high prevalence of the posterior relationship of CV to radial styloid process in the current study agreed and aligned with the information in reference books (Moore *et al*., 2018; Snell, 2019; Standring *et al*., 2020). Thus, this indicates that the CV is commonly found constant posterior to the radial styloid process; therefore, this relation is considered an important anatomical point for the identification of the CV, and venipuncture in this region may be more successful than in others.

CONCLUSION

There are five different venous patterns in the dorsal aspect of the hand, in Sudanese. The second and third DMVs have participated in the creation of most venous patterns. The union of the first dorsal metacarpal vein with the second is considered the best point to determine the beginning of the CV. A higher incidence of CV location posterior to the radial styloid process is considered a suitable point to find this vein during venipuncture.

Recommendations. The second and third DMVs should be the first to select during venipuncture due to their prominence and visibility, and the radial styloid process is considered a suitable point to search for CV during venipuncture.

ELGHAZALY, E.A. Variaciones anatómicas de los patrones venosos en el dorso de la mano y el inicio de la vena cefálica en sudaneses vivos. *Int. J. Morphol., 42(6)*:1700-1705, 2024.

RESUMEN: El conocimiento anatómico detallado de las venas dorsales de la mano y el inicio de la vena cefálica (VC) ayudará a garantizar una venopunción segura en muchas aplicaciones clínicas. Este estudio tuvo como objetivo evaluar las variaciones anatómicas de los patrones venosos en el dorso de la mano, el comienzo de la VC y su relación con el proceso estiloides del radio en indiviudos sudaneses vivos. Utilizando un torniquete y una cámara digital, se estudiaron las venas metacarpianas dorsales (VMD) de la mano y el comienzo de la VC en 440 manos sanas, 240 (54,5 %) de hombres y 200 (45,5 %) de mujeres, entre enero y abril de 2024. Se adoptaron dos métodos para identificar los patrones venosos, el recorrido de las venas varicosas más visibles y las comunicaciones entre ellas. Se observaron cinco tipos diferentes de patrones venosos; el patrón más común fue el tipo III (34 %), seguido del tipo II (29,5 %), mientras que el tipo VI (2,5 %) fue el menos observado. No se encontraron diferencias estadísticas entre los patrones venosos y el sexo, ni entre los lados derecho e izquierdo del cuerpo, (p>0,05). En (45,3 %) de los hombres y (46,2 %) de las mujeres, la VC se encontró que iniciaba en la confluencia de la primera y segunda venas metacarpianas dorsales. En el 76,6 % de los hombres y en el 78,5 % de las mujeres, la VC se discurría posteriormente al proceso estiloides del radio. La VC participaba en la formación de la mayoría de los patrones venosos. La unión de la primera con la segunda VC se considera el mejor punto para determinar el inicio de la VC. Una mayor incidencia de localización de la VC posterior al proceso estiloides del radio se considera un punto adecuado para encontrar esta vena durante la venopunción.

PALABRAS CLAVE: Variaciones anatómicas; Patrón venoso; Dorso de la mano.

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