MEDICAL SCIENCE

# Anatomical variations and the correlation between hand and forearm superficial vein types among medical students

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## ABSTRACT

*Background:* Veins are blood veins that transport deoxygenated blood to the heart. Because they convey oxygen-rich blood from the lungs to the heart, pulmonary veins are an exception. There are several types of veins in our body, comprising deep veins, superficial veins and connecting veins; Phlebotomy is the use of a needle to withdraw blood from a patient. Identifying the vein's location and the pattern will aid in providing better healthcare services to patients while reducing the risk of complications. *Aim:* Our study aimed to address the vein types and patterns among students in AL-Madinah Al-Munawwara. *Method:* This was a cross-sectional observational study among 207 participants; vein images were captured using a digital camera after applying a tourniquet above elbow joints. *Results:* Out of the 207 participants, vein types 2, 3 and 4 were the most reported ones among the sample; the pattern of the vein types also varies; the common ones reported were types b, c and a and there was an association between vein types and pattern in both arms and it was consistent in both hands. *Conclusion:* In conclusion, our study investigated the vein types and patterns yielded a better understanding of veins nature among students; these outcomes shall improve healthcare services provided to the patients.

**Keywords:** Veins, superficial, types, pattern, Saudi Arabia

## 1. INTRODUCTION

Vessels transfer nutrients to organs/tissues and transport waste away from organs/tissues in the blood. The vasculature's primary goal and significant role are to help the organism oxygenate (Alkadhim et al., 2015). Deoxygenated blood returns to the heart through capillaries, venules, veins, the right side of the heart and finally the lungs. Oxygenated blood from the lungs is supplied to the aorta on the heart's left side, then to the arteries,

arterioles and capillaries, where nutrients are exchanged. The capillaries are the primary sites for oxygen and nutrition loading and unloading (Alkadhim et al., 2015).

Four significant types of blood vessels are in the body, each of which functions in blood flow. Arteries are arteries with solid walls that perfuse organs. Capillaries are the primary sites of nutrition and waste exchange, connecting arteries and veins. Capillaries have the greatest cross-sectional area and overall surface area (Tucker et al., 2022). Veins are blood arteries with thin walls that carry oxygen-deprived blood back into the heart. Sinusoids take the place of capillaries in organs like the spleen, liver, red bone marrow, etc.; their main job is to make the immune system react to foreign antigens. Each blood vessel plays a unique role in blood flow, which is regulated by several variables that modify the physiology of blood flow (Tucker et al., 2022).

Veins are blood channels that transport oxygen-depleted blood to the heart. Pulmonary veins, on the other hand, transmit oxygen-rich blood from the lungs to the heart. Veins that run deep can be found in the muscles and bones (Germann et al., 2023). There are three types of veins; Deep veins are responsible for returning oxygen-depleted blood to your heart. Superficial veins are more minor than deep veins and superficial veins can be seen beneath the skin. The great saphenous vein is the most obvious vein in the body and perforator veins, also known as connecting veins, are prominent (Wang and Leedham, 2006).

Phlebotomy is the use of a needle to withdraw blood from a patient. This can be used for laboratory testing as a diagnostic tool to narrow down a differential diagnosis or as a treatment for certain illnesses. This exercise examines the phlebotomy method and its numerous clinical correlates (Ialongo and Bernardini, 2016). Phlebotomy has evolved to become an essential diagnostic and therapeutic procedure. Phlebotomy is now often utilized in therapeutic settings to have a better comprehension of a patient's clinical manifestations and treatment outcomes (Srikanth and Lotfollahzadeh, 2022).

Blood is often extracted from the medial cubital fossa. Numerous anatomical modifications are available in this region; the medial cubital vein is located in the cubital fossa and runs beneath the bicipital aponeurosis. In contrast to the optimum location for an IV site, the dorsum of the hand, the median cubital vein is the most usually utilized alternative because to its thick walls, which can sustain the negative pressures necessary when extracting blood (WHO, 2010).

The median cubital vein must be distinguished from the basilic vein, which travels medially up the arm. Due to the basilic vein's proximity to the artery and nerve, extra attention is required while collecting blood from it. A patient may experience considerable agony and discomfort if this area is punctured. When the medial antebrachial cutaneous nerve is severed at the basilic vein, the sensation in the medial forearm is gone. The lateral plantar area of the heel, as well as the cephalic and basilic veins in the cubital fossa, is other typical places for blood collection in newborns (Srikanth and Lotfollahzadeh, 2022).

In a therapeutic environment, veins' anatomy is vital for vein puncture treatments. From primary venous blood samples to intravenous catheterization, these techniques might vary. The median cubital vein is a well-known site for venous blood sampling. The biceps aponeurosis covers the median cubital vein, preventing hematoma development and protecting the vein (Nguyen and Duong, 2022). Vein diameters range greatly.

In most circumstances, the basilic vein is the most prominent superficial vein in the arm; however, the cephalic vein might be more significant on occasion. The variable is also the drainage of the basilic vein and it has been established that the basilic vein drains directly into the brachial or axillary vein. The cephalic vein provides several advantages to the microvascular surgeon. The cephalic vein's position in the forearm varies and dissection may mistakenly harm the vein. If the vein is damaged during flap elevation, thrombosis and subsequent flap necrosis may occur (Mukai et al., 2020).

Two pairs of superficial and deep veins drain the upper extremities. Because they are located on the surface of the deep fascia, superficial veins are clinically significant and tend to be used for cannulation. The deep vein accompanies the artery as the vena cava bifurcation to the middle of the arm where the axillary vein forms. The cranial and basilar veins are the two primary superficial veins. Both develop at the dorsal venous arch on the back of the hand. The cephalic vein is located on the lateral border of the biceps muscle in the arm, rises in the shoulder area to reach the deltoid pectoral groove, enters the deep fascia and empties into the axillary vein. The basilar vein runs from the biceps brachii medial border to the middle of the arm, pierces the deep fascia and joins the co-muscle of the brachial artery to produce the axillary vein (Jacob, 2008).

The cubital fossa superficial veins exhibit a broader range of anastomosis patterns than is typically supposed; earlier studies found up to 20% of these variances (Bekel et al., 2018). When the forearm's median vein (median antebrachial vein) continues with the two terminal branches of the median cephalic and median basilic veins, which connect the cephalic and basilic veins, respectively (Ukoha et al., 2013), the most common type of cubital venous arrangement develops as in Figure 1 (Yammine and Erić, 2017), there are 8 types of vein shapes identified in our forearm (Vučinić et al., 2016).

Genetic and hydrodynamic variables are hypothesized to significantly affect the variances of vein patterns inside the cubital fossa. Understanding ethnic and cultural differences, as well as normal and uncommon venous patterns, can provide more direct

access to these veins, especially in emergencies. Understanding the various venous patterns in the cubital fossa is also required for diagnostic, surgical, and therapeutic procedures (Hagen, 2023).

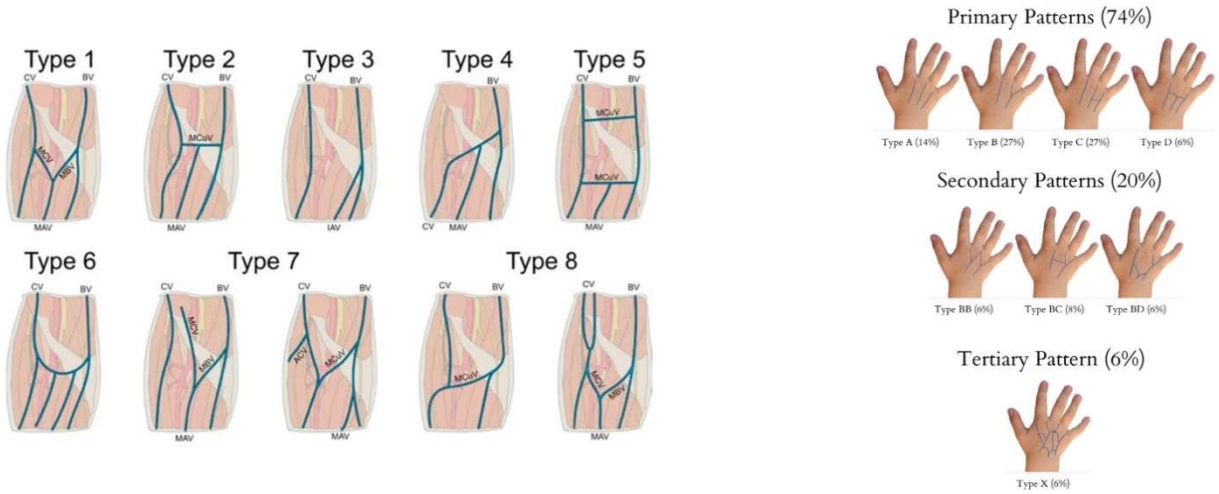


**Figure 1** Vein types and patterns in the forearm and hand (Yammine and Erić, 2017)

## 2. METHODS

This was a cross-sectional, survey questionnaire, observational study among Al-Rayan University, Al-Madinah, KSA students. It was carried out from December 2022 to March 2023. In 207 individuals from Al-Rayan Colleges, the pattern of superficial venous organization in the cubital fossa was noticed. After receiving informed verbal agreement from subjects, the researcher gathered data through observation after exposing both upper limbs distal to half of the arm and stretching the elbow joint in a supine posture. The tourniquet was then placed 10 cm proximal to the elbow crease for about three minutes with vigorous finger flexion and extension until the veins appeared for the examination.

The accuracy of the information was ensured by careful observation when the superficial cubital veins had become visible after the tourniquet was applied. The observed arrangement was recorded in the suitable gathering of data format and the vein pattern was captured using a digital camera before the tourniquet was removed. The statistical analysis was descriptive. Statistics were deemed meaningful at a P value equal to or less than (0.05).

We used the Raosoft program to calculate the sample size; the minimum effective sample was 200. Data were collected from 207 medical students in clinical years at Al-Rayan colleges. From each participant, we collected 4 different models (Right hand, Right forearm, left arrow, Left forearm). In our study, we included both gender, male and female, aged between 20 – 25; participants were excluded if there were pregnant or suffering from chronic diseases.

**Statistical Analysis**

This was a descriptive observational study with several variables, including gender and age; the outcomes of the participants were analyzed using GraphPad Prism 9.

## 3. RESULTS

**Study population and baseline characteristics**

In our study, 207 participants consented and enrolled in our screening, the mean age of the sample was 22.6, gender was comparable between male and female in which 48% were male and 52% were female and 83% of the sample were Saudis while 17% were other nationalities including Egyptian's, Sudanese's and Jordanian's (Table 1).

**Vein's position and type at the forearm**

Across the participated sample, screening for vein positions and types at the forearm was addressed for the right and left arms; among our sampled students, most participants have vein positions of 3, 2 and 4 with comparable outcomes of 30%, 28% and 27% for right forearm vs 25.6%, 27.1% and 25.1% in the left forearm respectively. A higher proportion of participants, 17.9%, had vein position 1 in the left forearm vs 8.2% only in the right forearm. In contrast, 4.3% of participants had vein position 5 in the right

forearm vs only 2.4% in the left forearm (Table 2). A sample of vein types in the forearm was presented in (Figure 2). The correlation between the right and left forearm towards the veins type was non-significant (p=0.175) for the right forearm, while it was significant for the left forearm (p=0.0371).

**Table 1** Baseline characteristics

| Baseline characteristics (n=207) | |
|---|---|
| Age | |
| Mean avg. | 22.6 Years SD =1.6515 |
| Sex | |
| Male n (%) | 100 (48%) |
| Female | 107 (52%) |
| Nationality | |
| Saudi | 171 (83%) |
| Non-Saudi | 36 (17%) |

**Table 2** Vein's position at the forearm

| Vein's position at the forearm | | |
|---|---|---|
| | Right forearm | Left forearm |
| Type 1 | 17 (8.2%) | 37 (17.9%) |
| Type 2 | 58 (28%) | 56 (27.1%) |
| Type 3 | 62 (30%) | 53 (25.6%) |
| Type 4 | 56 (27%) | 52 (25.1%) |
| Type 5 | 9 (4.3%) | 5 (2.4%) |
| Type 6 | 2 (1%) | 1 (0.5%) |
| Type 7 | 3 (1.4%) | 3 (1.4%) |


**Figure 2** Sample of vein types in the forearms. B: Basilic vein; C: Cephalic Vein; MAV: Median Antebrachial Vein; MCV: Median Cephalic Vain; MBV: Median Basilic Vain

**Vein's pattern type in hand**

Types and patterns of veins were studied as well in our study; the data of the 207 participants concerned with the type of veins in both hands were captured as per Table 3, in which we classified veins pattern according to a, b, c, d, bb, bc, bd and x, as in Table 3,

the most reported pattern types were b, c and a respectively, 31.4 and 31.9% of participants reported pattern b in the right hand and the left hand respectively (Table 3). In contrast, pattern c was reported in 25.1 and 27.1% in the right and left hand. A sample of vein patterns in the hand was captured in (Figure 3). The correlation between veins pattern type in the hand either right or left was tested statistically, there was a substantial relationship between the veins pattern and the right and left hands, with p-values of (p=0.01) and (p=0.016) respectively.

**Table 3** Vein patterns in hand

| Vein's pattern types in hands | | |
|---|---|---|
| | Right hand | Left hand |
| a | 37 (17.9%) | 30 (14.5%) |
| b | 65 (31.4%) | 66 (31.9%) |
| c | 52 (25.1%) | 56 (27.1%) |
| d | 15 (7.2%) | 18 (8.7%) |
| bb | 9 (4.3%) | 8 (3.9%) |
| bc | 12 (5.8%) | 16 (7.7%) |
| bd | 9 (4.3%) | 9 (4.3%) |
| x | 8 (3.9%) | 4 (1.9%) |

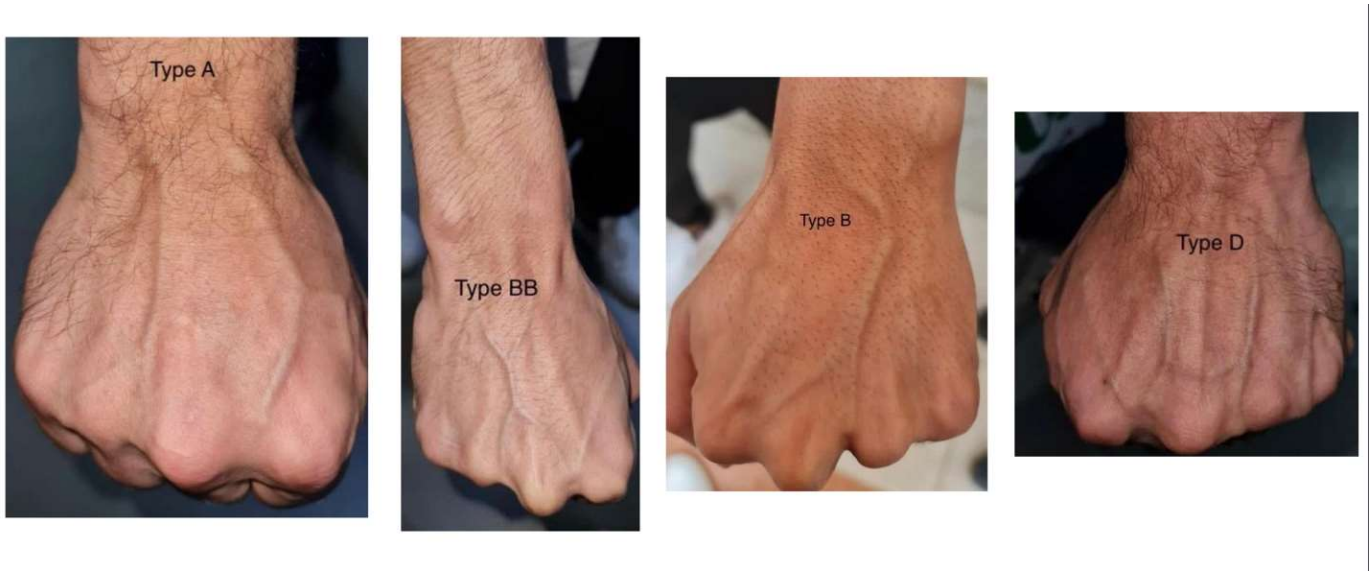


**Figure 3** Sample of vein patterns in the hand

**Forearm vein types about hand vein's pattern**

The relation between vein position in the forearm and the vein's pattern type in the hand was addressed in our study; the findings of this were illustrated (Figure 4, 5). In the right hand, the most reported vein pattern in vein types 2, 3 and 4 were b, c and a respectively, there was a non-significant difference when we tried to build a correlation between the right forearm vein type and right-hand vein pattern with p-value (p=0.185). While for the left hand, the most reported vein pattern in vein types 2, 3 and 4 was the same as the right hand, b, c and a, however with higher magnitude among participants in the left hand than the right hand. In opposition to the right hand, there was a p-value (p=0.0499) distinction between the left forearm vein type and the left-hand vein pattern.

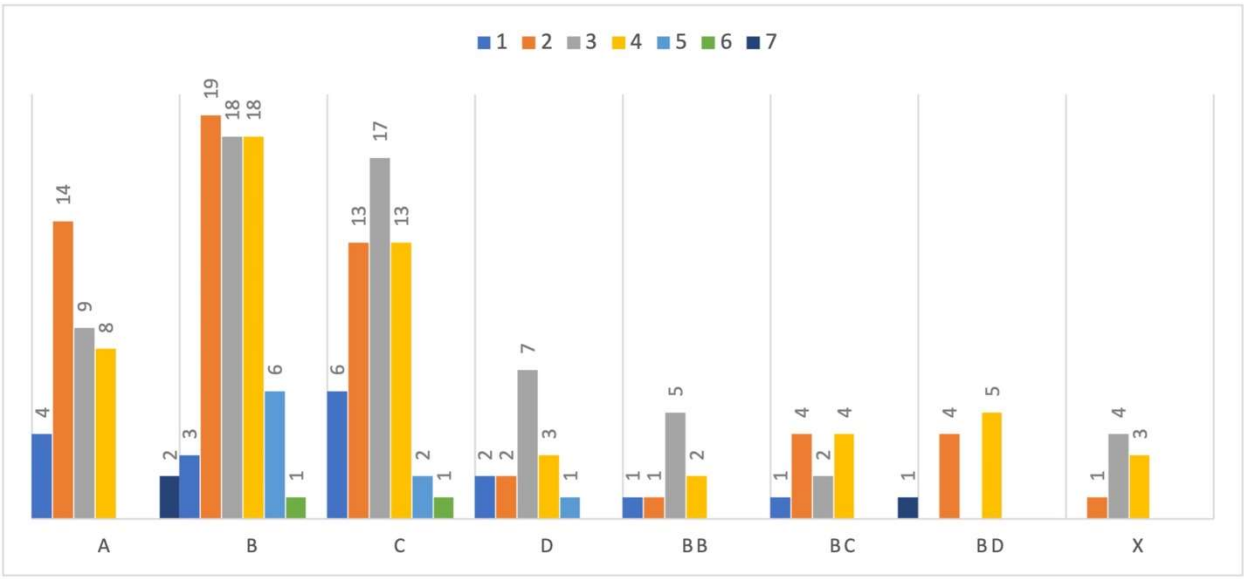


**Figure 4** Right forearm veins about right-hand vein patterns

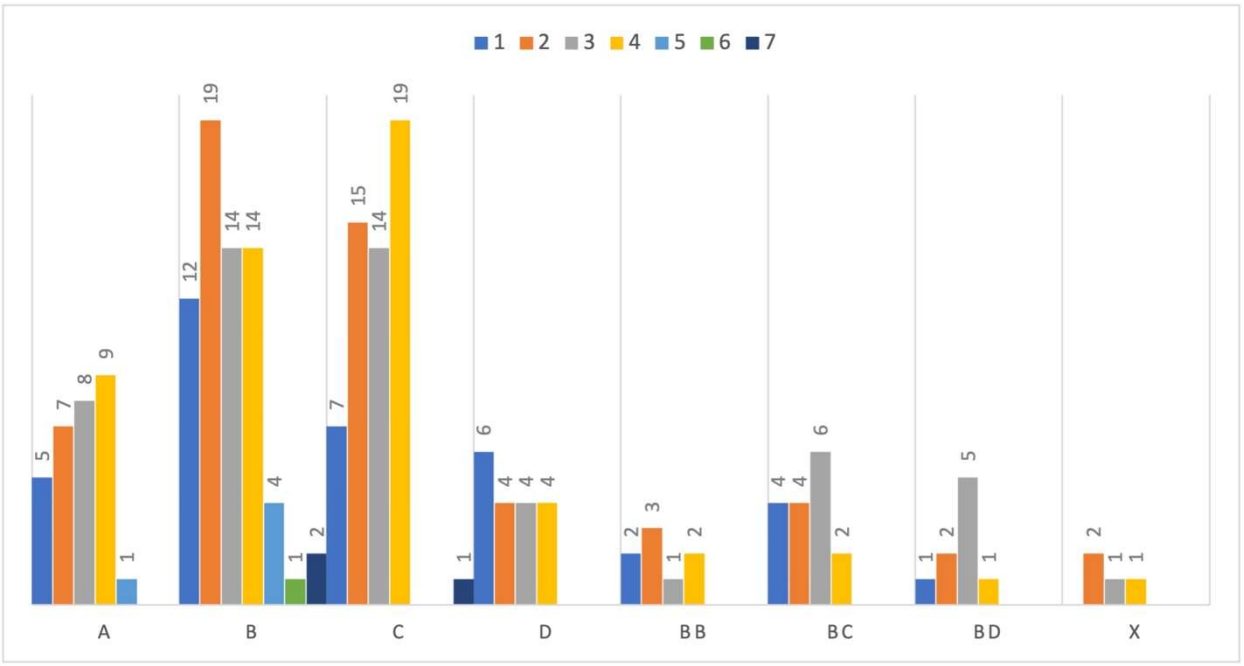


**Figure 5** Left forearm veins about left-hand vein patterns

**Hand vein patterns and the vein types in the forearm**

As earlier explained, the association between veins types and positions between the forearm was addressed; here, we explored the association between hand veins pattern and forearm vein types in both the right and left hand; as in Figure 6 and 7, there was a strong association between vein's pattern a, b and c with the presence of veins position 3, 2 and 4 respectively among right hands of the participants, this outcome was precisely consistent in the left hand, across investigating left hand of the participants, the veins pattern b, c and a were the top-ranked and the veins positions were again the 3, 2 and 4 predominantly reported.

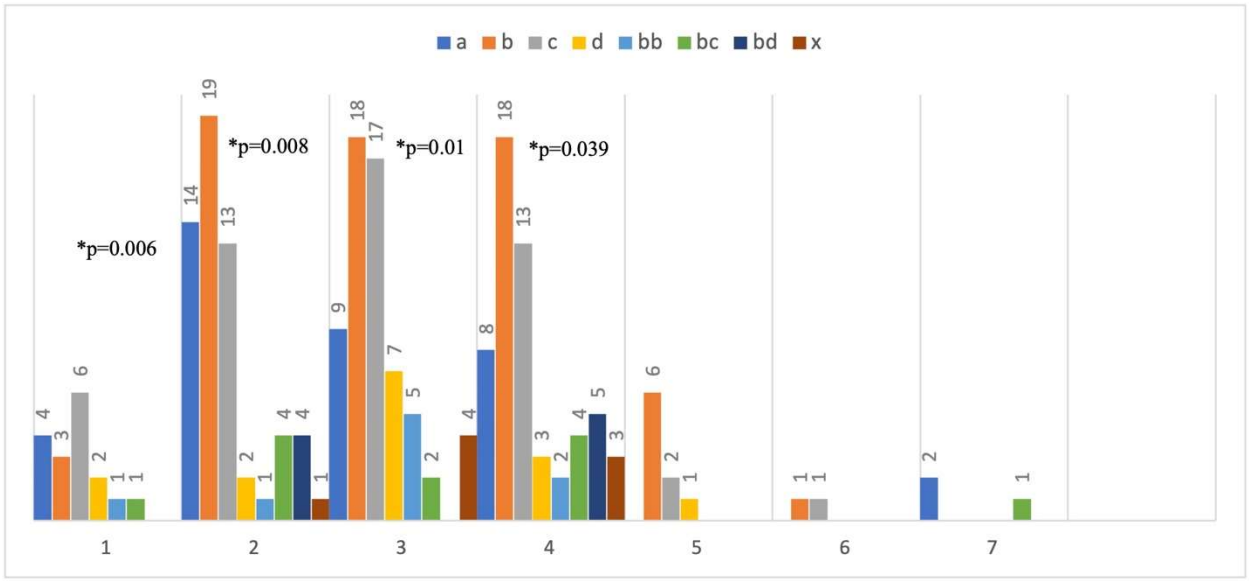


**Figure 6** Right-hand veins about right forearm vein type

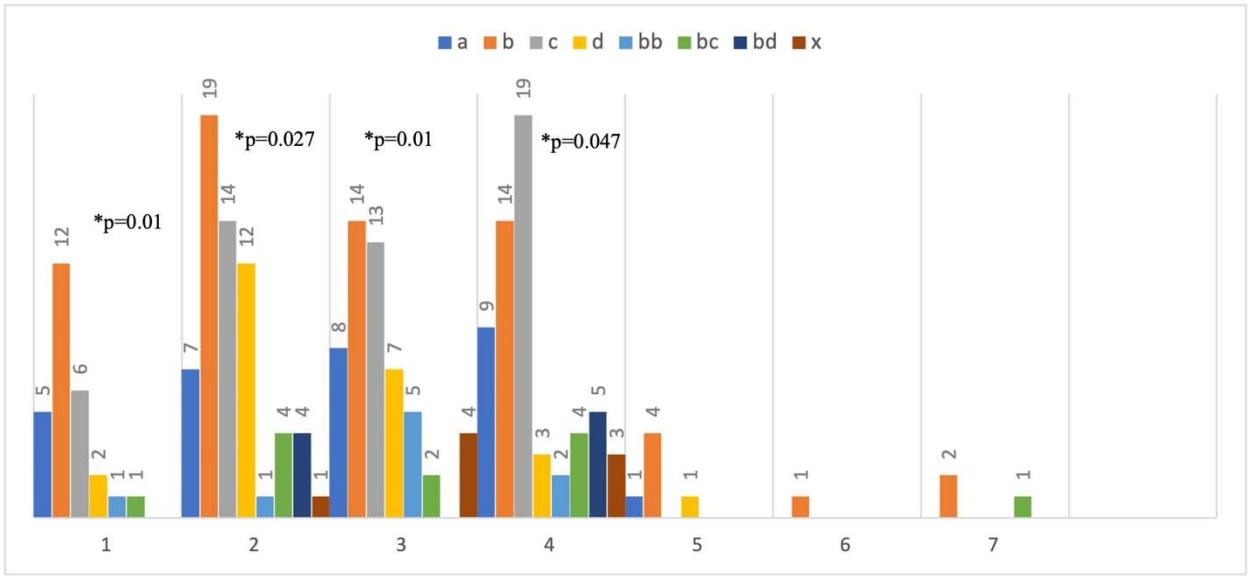


**Figure 7** Left-hand veins about left forearm vein type

## 4. DISCUSSION

The appearance of the upper limb's superficial veins varies greatly. During the embryonic stage of life, veins emerge from the capillary plexus. Veins become bigger by anastomosing into one another and finally merging to form fewer and larger channels. Genetic and hydrodynamic factors significantly impact the final pattern of the vein pattern; this might cause variations in the cubital fossa venous pattern (Vasudha, 2013). Variations in the cubital fossa's venous pattern can occur for various causes. Because they are simple to access and drain a considerable amount of blood from the upper limb, the upper limb's superficial veins are often employed in clinical practice for procedures such as venipuncture and the formation of arteriovenous fistulas in hemodialysis patients (Elamurugan and Hemachandar, 2017).

Our study aims to examine the various types of veins and vein patterns in the upper limb superficial veins of Al-Madinah students. Our inquiry yielded a condensed examination of the various types of veins in both forearms and the vein pattern type in the hands. In addition, we established a link between forearm veins and hand veins. Regarding vein types in the forearm, our research found that the most often reported vein types in the right hand were numbers 3, 2 and 4, while the most frequently reported ones in the left hand were numbers 2, 3 and 4, this finding is consistent with the venous pattern reported in previous research (Lee et al., 2015).

In terms of vein patterns, we investigated the numerous vein pattern kinds, such as a, b, c, d, bb, bc, bd and x. The findings of this inquiry were thoroughly examined and it was discovered that type b (31.7 percent) was ahead of other patterns reported by the bulk of the sample, followed by type c (26.1 percent) and type a (16.2%). This was true of both hands. Furthermore, this conclusion was compatible with the findings of prior research, such as a meta-analysis of superficial vein patterns in the cubital fossa (Yammine and Erić, 2017).

This result was investigated on the sample's high association with particular types and patterns. In our study, vein types 2, 3 and 4 were more closely related to vein pattern types b, c and a and this result was comparable in both hands. There was a substantial correlation between vein types and patterns across the forearm and hand in both hands (right and left). This result was investigated on the sample's high association with types and patterns. Our work had some limitations, the most prominent of which was its small sample size and unicentric design; nevertheless, its strengths were the use of novel methodologies for vein detection and a good randomization of samples across male and female individuals.

## 5. CONCLUSION

In conclusion, there was an association between vein type and pattern across participants; the major types of veins reported were Type 2, 3 and 4, along with vein pattern types b, c and a; the outcomes of this study shall improve healthcare providers and nurses' performance in the blood extraction, laboratory analysis and dialysis among Saudi population.

**Acknowledgment**

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**Author contribution**

The authors value the participants' input. Contributions of the authors: WJ and AK developed the approach and wrote the text. The NZ, AK, WK and RR were involved to collect samples. MK oversaw and participated in the project's planning, statistical evaluation and article preparation phases. The final draft was read by all writers before being approved.

**Informed consent**

Verbal consent was obtained from all individual participants included in the study.

**Ethical approval**

The official permission was approved by the Al-Rayan Research Ethics Committee (HA-03-M-122-018). Participation was voluntary and written informed consent from all the participants after describing the aim of the study. Privacy and confidentiality were assured.

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This study has not received any external funding.

**Conflict of interest**

The authors declare that there is no conflict of interests.

**Data and materials availability**

All data sets collected during this study are available upon reasonable request from the corresponding author.

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