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Original Article

Assessment of morphological variations in superficial veins of upper limb with or without artificial discoloration of skin using Near-Infrared Illumination device in adults (Hyderabad region)

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Abstract

Objective Venous puncture is the process of obtaining intravenous access to get blood samples. Superficial veins of upper-limb, mainly dorsal metacarpal veins and median cubital veins are the commonest site for access. In order to get acquaintance about anatomic variation to perform safe venous puncture, the main objective of this study was to examine the variations in superficial veins of upper limb by using Near-Infrared Illumination Device.

Methods A sample size of 50 participants (100 records of both limbs) has been documented. Staff and students of LUMHS of both genders; with the age ranging from 18-60 years, were included in the study. Tourniquet/ Blood Pressure monitor cuff application was applied to visualize superficial cubital veins. Another technique of Near-infrared illumination device (sure view vein illumination system ZD-JM-260-01) was applied to observe superficial veins of hand dorsum in adults with and without Hinna (Mehndi) causing artificial discoloration of skin.

Results The Study results showed that 46(92.0%) of the total participants reported Type A right arm cubital fossa. 47(94.0%) reported Type A left cubital fossa. 15(30.0%) of the male participants had Type 6 Right hand dorsum venous arrangement. Likewise, 5(10.0%) of the female participants had Type 6 right hand dorsum venous arrangement. 14(28.0%) male participants had Type 6 Left hand dorsum venous arrangement. Similarly, 7 (14.0%) males had Type 2, and 13(26.0%) males had Type 3 left hand dorsum venous arrangements. 5 (10.0%) of the female participants had Type 3 left hand dorsum venous arrangement. 03 adult females presented with Henna (Mehndi) already applied on dorsum of hands and superficial veins were as visible as in rest of subjects without application of Henna (Mehndi).

Conclusion Type-A was observed most frequently in venous arrangement in cubital fossa of both left and right arms of the participants, while Type 6 was the most generally observed type in hand dorsum of both right and left arms. Artificial discoloration of skin caused by Henna (Mehndi) did not seem to effect the visibility of vein structure.

Key words
Cubital fossa; Near-infrared illumination device; Superficial veins; Hand dorsum.

Introduction

Venous puncture is the process of gaining intravenous access to obtain a blood sampling in an emergency situation which is executed by health care workers, such as doctors, nursing staff, and emergency medical technicians.[1] Veins are categorized on the basis of their position related to deep fascia in the deep superficial veins and communicate with each other through perforating veins. Site of the superficial veins in the superficial fascia

presents a simple way for blood drawing and cannulation for clinical analysis of blood.[2] These veins of the cubital fossa are the most frequent veins that are used for blood-samples, blood-transfusions, and intravenous injections at critical situations. These superficial veins are also utilized to direct cardiac catheters to the chambers of heart to collect blood sampling. In addition, they are used during angiography and placement of dialysis catheter.[3] Cubital fossa exists on the anterior part of upper limb in the area of elbow joint.[4] This space consists of main vessels, lymph nodes, nerves, and fats.

Superficial veins of upper limbs are more beneficial as compared to superficial veins of lower limbs because venous access of lower limbs is less resilient, and reflected more complications, such as pulmonary embolism and deep vein thrombosis.[5,6] Furthermore, patient's movement also restricts by venous access in the lower limbs.[7] Superficial veins of forearm, hand dorsum, and rarely the foot, have frequently been utilized for venous access.[8] Dorsal metacarpal veins (MCVs), basilic vein (BV), and cephalic vein (CV), are most frequent places of venous access among all superficial veins.[6] Superficial veins of hands are digital, metacarpal, and the beginning of BV on the ulnar side whereas CV on the radial side on dorsum of hand. Superficial veins on hand dorsum are simply palpable, easily detectable, and surrounded by the metacarpal bones. Dorsal MCVs are the primary option for veins cannulation mainly in the pediatric patients,[9] whereas, the distal part of CV has been recommended for vein piercing.[10] It has been specified that catheterization of veins in hand dorsum in the obstetric patients is more successful as compared to veins used in the region from elbow joint to hand.[11] Though, in emergency conditions, the median cubital vein of forearm is the primary option for cannulation.[6]

A benefits of using dorsal MCVs is the ease of access along with position of the veins distally that support the use of more proximal veins in the similar upper limb as desired.[11] Additionally, few drawbacks are associated with these veins such as smaller size and have a propensity of mobility.[12]

There are many variations of superficial veins exist in cubital fossa that are categorized into four or six types by researchers on the basis of course of the superficial veins.[13] Currently, numerous devices, by using infrared reflection, are produced to enhance peripheral venous puncture.[14,15]

These superficial veins are perfectly recognized for cannulation by guiding rules proposed by the 'American Society of Diagnostic and Interventional Nephrology and the National Kidney Foundation' for patients having chronic illnesses like chronic renal disorder.[16] An additional purpose of these dorsal veins is their growing recognition and function as accepted biometric parameters. The potential of dorsal metacarpal veins in biometric rationale is continuously being revealed. For this purpose, contemporary efforts have promoted the use of infrared thermography.

Due to its broad range of application to visualize superficial veins, the probable function of infrared thermography in normal medical practice has been comprehensively inspected. Imaging of vein is useful in paediatrics venous puncture which is the center of attention of contradictory researches.[17] So far, statistics supports the application of vein imaging in

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medical settings. The morphological variations in superficial veins in cubital fossa, are well recognized in different parts of the globe.[18,19] It is also evidently reported in earlier studies that gender and ethnicity had a positive influence on variations in patterns of superficial veins of cubital fossa as well as dorsal venous plexus.[20,21]

The main purpose of this research was to examine morphological variations in superficial veins and types of superficial venous arrangements that present in cubital fossa and dorsal aspect of the hand of the right and left upper limb using a near-infrared illumination device in adults of the Hyderabad region, Pakistan.

Methods

This was a cross-sectional study which was conducted in the Department of Anatomy, Liaquat University of Medical & Health Sciences (LUMHS) after approval from the Ethical Research Committee (ERC) and Board of advanced studies and research (BASR) of (LUMHS). It used a non-probability convenience sampling technique. The duration was about six months after approval. A sample size of 50 participants (100 records of left and right upper limbs) had been documented for collecting data and analysis.

Staff and students of LUMHS of both genders having age ranging from 18-60 years, were included in the study. Participants having thick skin, presence of wound and scars in the cubital fossa and on the hand dorsum and those individual that were not willing to participate were excluded from the study.

Two techniques were used in order to visualize superficial veins. Tourniquet/Blood Pressure monitor cuff application was applied to visualize superficial cubital veins at about 23-26 ^{0}C temperature. This method was repeated for right and left arms. Another technique Near-infrared illumination device (sure view vein Illumination system ZD-JM-260-01) was applied to observe superficial veins of hand dorsum; the gadget light was aimed at a targeted region indicated by few imaginary lines. The near-Infrared illumination technique was applied as deoxygenated Haemoglobin-rich blood present in veins that entirely take up light at near-infrared wavelengths (740 nm-760 nm) from the several centimeters distance. Oxygenated blood that flows in arteries does not absorb light of 740 nm-760 nm wavelength. This distinctive aspect of veins makes them visible in infrared light. Pictures of each of the participants' cubital fossa and hand dorsum (right and left) were taken. Another technique of Near-infrared illumination device was applied to observe superficial veins of hand dorsum in adults with and without Hinna (Mehndi) causing artificial discoloration of skin.

Collected data was analyzed using SPSS version 23.0. While for qualitative variables; frequencies and percentages were reported.

Results

A total of 50 participants of both genders were selected in which 38 were males and 12 were females. **Table 1** showed the four types of cubital fossa. Examination of the right arm cubital fossa revealed that about 36(72.0%) males had Type A cubital fossa, whereas only 1(2.0%) had Type B and C each. No had Type D cubital fossa. 10 (20.0%) female participants had Type A cubital fossa, On the other hand, 2(4.0%) had Type B cubital fossa. None of the female had Type C and D cubital fossa.

Table 1 Frequency of type of superficial vein in right cubital region of both genders.

Gender	*Type-A*	*Type-B*	*Type-C*	*Type-D*
Female	10(20.0%)	2(4.0%)	0	0
Male	36(72.0%)	1(2.0%)	1(2.0%)	0
Total	46(92.0%)	3(6.0%)	1(2.0%)	0

Table 2 Frequency of type of superficial vein in left cubital fossa for both genders.

Gender	*Type-A*	*Type-B*	*Type-C*	*Type-D*
Female	10(20.0%)	2(4.0%)	0	0
Male	37(74.0%)	1(2.0%)	0	0
Total	47(94.0%)	3(6.0%)	0	0

46 (92.0%) of the total participants reported Type A right arm cubital fossa, as shown in **Table 1**.

Examination of the left arm cubital fossa revealed that about 37(74.0%) males had Type A cubital fossa, whereas only 1 (2.0%) had Type B. None had Type C and D cubital fossa. Likewise, 10(20.0%) female participants had Type A cubital fossa, On the other hand, 2(4.0%) had Type B cubital fossa. None of the female had Type C and D cubital fossa. 47(94.0%) of the total participants reported Type A left cubital fossa, as shown in **Table 2**.

Right hand dorsum venous arrangement reported that 15(30.0%) of the male participants had Type 6 venous arrangement. 8(16.0%) males had Type 2 and 8(16.0%) had Type 3 hand dorsum venous arrangements. 4(8.0%) males had Type 5 venous arrangement in the right-hand dorsum, while 3(6.0%) had Type 8. None of the male participants had Type 1, 4 and 7. 5 (10.0%) of the female participants had Type 6 hand dorsum venous arrangement. While 3 (6.0%) and 2 (4.0%) females had Type 2 and 3 hand dorsum venous arrangements, respectively. 2 (4.0%) females had Type 5 venous arrangement. None of the female participants had Type 1, 4, 7 and 8 right-hand dorsum, as shown in **Table 3**. Left hand dorsum venous arrangement reported that 14 (28.0%) of the male participants had Type 6 hand dorsum venous arrangement in their left hands. 7 (14.0%) males had Type 2, and 13 (26.0%) males had Type 3 hand dorsum venous arrangements. 3 (6.0%) males had Type 5 venous arrangement, while 1(2.0%) had Type 7. None of the male participant had Type 1, 4 and 8. 5 (10.0%) of the female participants had Type 3 hand dorsum venous arrangement. 4 (8.0%) and 5 (10.0%) females had Type 2 and 3 hand dorsum venous arrangements, respectively. 1 (2.0%) female participants had Type 1, Type 5 and Type 6, each venous arrangement in the left-hand dorsum. None of the female participants had Type 4, 7 and 8 left-hand dorsum, as shown in **Table 4**.

Findings over Visibility of Dorsum of hand with Hinna (mehndi) application in females participants are mentioned in **Table 5**. 3 adult females presented with Henna (Mehndi) already applied on dorsum of hands and superficial veins were as visible as of subjects without application of Henna (Mehndi).

Table 3 Frequency of type of superficial vein in right hand dorsum for both genders.

Gender	*Type-1*	*Type-2*	*Type-3*	*Type-4*	*Type-5*	*Type-6*	*Type-7*	*Type-8*
Female	0	3(6.0%)	2(4.0%)	0	2(4.0%)	5(10.0%)	0	0
Male	0	8(16.0%)	8(16.0%)	0	4(8.0%)	15(30.0%)	0	3(6.0%)
Total	0	11(22.0%)	10(20.0%)	0	6(12.0%)	20(40.0%)	0	3(6.0%)

Table 4 Frequency of type of superficial vein in left hand dorsum for both genders.

Gender	*Type-1*	*Type-2*	*Type-3*	*Type-4*	*Type-5*	*Type-6*	*Type-7*	*Type-8*
Female	1(2%)	4(8%)	5(10%)	0	1(2%)	1(2%)	0	0
Male	0	7(14%)	13(26.0%)	0	3(6%)	14(28%)	1(2%)	0
Total	1(2%)	11(22%)	18(36%)	0	4(8%)	15(30%)	1(2%)	0

Table 5 Visibility of dorsum of hand with hinna (mehndi) application in females participants.

Total female Participants	*Dorsum of hand without discoloration by Hinna (Mehndi)*	*Dorsum of hand with discoloration by Hinna (Mehndi)*	*Visibility of veins with and without discoloration*
12 (100%)	09 (75 %)	03 (25%)	Equally good

Discussion

Venipuncture is the frequently performed method to draw blood by healthcare workers in cubital area where superficial venous arrangement exists in different patterns.[17] In order to perform safe venous puncture, it is mandatory to be aware regarding variations of cubital venous pattern. Knowledge about unusual cubital vein patterns can prevent harm against adjacent cutaneous arteries along with nerves. Insufficient awareness leads to several undesired punctures, subcutaneous hemorrhage and discoloration of skin.[22] The present study demonstrated the different patterns of superficial veins in the cubital region and dorsal aspect of hand of upper limb in order to perform safe venous puncture.

One research showed the insignificant effect of gender on venous pattern of cubital area of upper limbs. It was also proved that the left and right side of upper limb showed insignificant differences in both genders.[16] This reported incidence of the venous arrangement was similar to an earlier Asian study[23] that indicated the prevalence of types A, B, C, and D documented as 41.7%, 56.7%, 1.7%, and 0%, respectively. The present study showed that there was no gender influence in addition to right and left side on venous arrangement of cubital region of upper limbs. The frequencies of Types: A, B, C, and D in the right cubital fossa were reported as 46 (92.0%), 3 (6.0%), 1 (2.0%) and 0% respectively. However, they were reported as 47 (94.0%) and 3 (6.0%) in type A and B, respectively, in the left cubital fossa.

Lack of median cubital vein or connecting branches involving cephalic and basilic veins, were considered as type IV and was seen in 1 female and 3 males in the upper limbs. The type III that is formed by the improper progression of CV was noted in 1 female and 6 male in upper limbs. Even though the reported frequencies of these rarely found types i.e. Type III and IV cubital vein arrangement were observed higher in males as compared to females, the difference was not statistically significant.[16] As far as the present study is concerned, only 1(2.0%) male had Type C pattern in the right cubital region while none of the participants showed Type D in right arm and Type C and D in left upper limb.

Similarly, in another research, frequency of Type-A of cubital venous arrangement was 72.18%, in which 28.57% were in right arm and 43.61% in the left arm of the participants. Their research showed increased prevalence of Type-A pattern in females (52.26%) as compared to males (19.92%).[24] The incidence of Type-A venous arrangement in another study, was higher to some extent than the analysis performed by Yammine Eric that reported 25%.[25] The current study was consistent with the above reported research. It can be observed that Type A in right and left cubital fossa venous arrangement is the most common among male and female participants. 94% of the total participants showed that they had Type A left arm cubital fossa, while the remaining 6% had type B. On the other hand, 46 (92.0%) of the total participants showed Type A in the right arm cubital fossa.

In the present study, Type-A cubital venous pattern were more frequently observed in males 37 (74.0%) than females 10 (20.0%), which was consistent with another research conducted in Malays in which 18.8% were males and 11.5% were females with Type-A cubital venous pattern.[26]

A research conducted in University of Jordan revealed arrangement of Type-A cubital venous pattern was found to be 18.2% in males and 16.6% in females[27] The current study reported higher incidence of Type-A venous pattern in

males than females.

It is recognized that most commonly reported locations of venous puncture are superficial venous pattern of upper limb, predominantly are median cubital vein and dorsal metacarpal veins. Consequently, another cross sectional analysis conducted in Jordan (including 402) subjects investigated dorsal metacarpal veins and found major dorsal metacarpal vein by using infrared illumination system. Six sites of most important dorsal metacarpal veins were recognized and revealed significant association between both genders vein. Their study also recognized the most commonly reported site of dorsal metacarpal vein which is the fourth inter metacarpal space.[28] As far as the present study is concerned, eight anatomical locations of Meta carpal veins in hand dorsum were identified in which Type 3 was the most common type of venous arrangement followed by type 6 and 2 in left hand among male and female participants. In right hand dorsum, Type 6 was the most common type followed by Type 2 and 3.

The findings of this study can be applied in medical practice in order to perform safe venous puncture. Health care workers can proficiently carry out a variety of medical processes in Pakistan with no concern about finding any anonymous type of venous arrangements in the cubital fossa and hand dorsum of the patients.

Conclusion

This study concluded that there was no difference seen in the venous pattern of participants on the basis of gender. The most frequently observed type was Type-A in cubital fossa in both left and right arms of the participants, while Type 6 was the most generally observed type in hand dorsum of both right and left arms. Moreover. artificial discoloration of skin caused by Henna (Mehndi) did not seem to effect the visibility of vein structure.

References

1. Adhya S, Shee B, Biswas S. Anatomical variation of superficial venous arrangement in cubital fossa. *Journal of Indian Academy of Forensic Medicine*.2016;**38(2)**:201-4. DOI:10.5958/0974-0848.2016.00052.X.
2. Lee SH, Chun KJ, Lee DS, Lee SY, Hwang J, Chon MK, et al. Right Cardiac Catheterization Using the Antecubital Fossa Vein in Korean Patients. *Korean Circ J*. 2016;**46(2)**:207-12.
3. Williams PD, Palmer S, Judkins C, Gutman J, Whitbourn R, MacIsaac A, et al. Right and left heart catheterization via an antecubital fossa vein and the radial artery--a prospective study. *J Invasive Cardiol*. 2014;**26(12)**:669-73.
4. Bekel AA, Bekalu AB, Moges AM, Gebretsadik MA. Anatomical variations of superficial veins pattern in Cubital fossa among north west Ethiopians. *Anatomy Journal of Africa*. 2018;**7(2)**:1238-43.
5. Scales K. Vascular access in the acute care setting. In: Dougherty L, Lamb J, editors. Intravenous Therapy in Nursing Practice. Oxford: Blackwell Publishing; 2008. p.261-99.
6. Ortega R, Sekhar P, Song M, Hansen CJ, Peterson L. Videos in clinical medicine. Peripheral intravenous cannulation. *N Engl J Med*. 2008;**359(21)**:e26.
7. Mbamalu D, Banerjee A. Methods of obtaining peripheral venous access in difficult situations. *Postgrad Med J*. 1999;**75(886)**:459-62.
8. Cheung E, Baerlocher MO, Asch M, Myers A. Venous access: a practical review for 2009. *Can Fam Physician*. 2009;**55(5)**:494-6.
9. King C, Henretig FM. Textbook of pediatric emergency procedures. Philadelphia, PA: Lippincott Williams & Wilkins; 2008.
10. Loukas M, Tubbs RS, Feldman J. Netter's introduction to clinical procedures. Philadelphia, PA: Elsevier Health Sciences; 2016.
11. Tan PC, Mackeen A, Khong SY, Omar SZ, Noor Azmi MA. Peripheral Intravenous Catheterisation in Obstetric Patients in the Hand or Forearm Vein: A Randomised Trial. *Sci Rep*. 2016;**6**:23223.

12. Elmegarhi SS, Amarin JZ, Hadidi MT, Badran DH, Massad IM, Bani-Hani AM, Shatarat AT. Dorsal metacarpal veins: anatomic variation and potential clinical implications. *Anat Sci Int*. 2018;**93(2)**:238-243.
13. Mikuni Y, Chiba S, Tonosaki Y. Topographical anatomy of superficial veins, cutaneous nerves, and arteries at venipuncture sites in the cubital fossa. *Anat Sci Int*. 2013;**88(1)**:46-57.
14. Hess HA. A biomedical device to improve pediatric vascular access success. Pediatr Nurs. 2010;**36(5)**:259-63.
15. Kaddoum RN, Anghelescu DL, Parish ME, Wright BB, Trujillo L, Wu J, et al. A randomized controlled trial comparing the AccuVein AV300 device to standard insertion technique for intravenous cannulation of anesthetized children. *Paediatr Anaesth*. 2012;**22(9)**:884-9.
16. Lee H, Lee SH, Kim SJ, Choi WI, Lee JH, Choi IJ. Variations of the cubital superficial vein investigated by using the intravenous illuminator. *Anat Cell Biol*. 2015;**48(1)**:62-5.
17. Pires L, Rafare AL, Peixoto BU, Pereira TOJS, Pinheiro DMM, Siqueira MEB, et al. The venous patterns of the cubital fossa in subjects from Brazil. Morphologie. 2018;**102(337)**:78–82.
18. Ukoha UU, Oranusi CK, Okafor JI, Ogugua PC, Obiaduo AO. Patterns of superficial venous arrangement in the cubital fossa of adult Nigerians. *Niger J Clin Pract*. 2013;**16(1)**:104-9.
19. Silva MRMA, Henriques JGB, Silva JH, Camargos VR, Moreira PR. Venous arrangement of the head and neck in humans-anatomic variability and its clinical inferences. *Journal of Morphological Sciences*. 2016;**33(01)**:022-028.
20. Vazquez T, Sanudo J. Veins of the Upper Limb. Bergman's Comprehensive Encyclopedia of Human Anatomic Variation. 2016:826–31.
21. Vučinić N, Erić M, Macanović M. Patterns of superficial veins of the middle upper extremity in Caucasian population. *J Vasc Access*. 2016;**17(1)**:87-92.
22. Alves N. Formações venosas superficiais da fossa cubital: aspectos de interesse para a pratica da Enfermagem [Superficial venous formation of the cubital fossa: aspects of interest for nursing practice] *Rev Bras Enferm*. 2012;**65(6)**:1030–3.
23. Yamada K, Yamada K, Katsuda I, Hida T. Cubital fossa venipuncture sites based on anatomical variations and relationships of cutaneous veins and nerves. *Clin Anat*. 2008;**21(4)**:307-13.
24. Manandhar B, Shrestha R. Type A Cubital Venous Pattern among Students of a Dental College: A Descriptive Cross-sectional Study. *JNMA J Nepal Med Assoc*. 2021;**59(238)**:547-9.
25. Yammine K, Eric M. Patterns of the superficial veins of the cubital fossa: A meta-analysis. *Phlebology*. 2017;**32(6)**:403–14.
26. Dharap AS, Shaharuddin MY. Patterns of superficial veins of the cubital fossa in Malays. *Med J Malaysia*. 1994;**49(3)**:239–41.
27. Albustami F, Altarawneh I, Rababah E. Pattern of superficial venous arrangement in the cubital fossa of adult Jordanians. *J Med J*. 2014;**48(4)**:269–74.
28. Salameh MA, Shatarat AT, Badran DH, Abu-Abeeleh MA, Massad IM, Bani-Hani AM. The best vein to be accessed based on descriptive study of dorsal metacarpal vein. *Anat Cell Biol*. 2019;**52(4)**:390-6.