Venous Anatomic Variations in Brachial Fossa Encountered during a Construction of Arteriovenous Fistula

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Abstract

Objective: To study venous pattern in brachial fossa of the patients undergoing arteriovenous fistula (AVF) construction. Presence of perforating veins was also assessed.

Methods: This was a retrospective descriptive study which evaluated the anatomic variations of brachial fossa venous pattern in 196 end-stage renal disease (ESRD) patients. All patients were referred to the Department of Surgery, Faculty of Medicine Vajira Hospital, University of Bangkok Metropolis during February 2005 and April 2010 for AVF construction. The drawing illustrations as well as the description of the antecubital veins were reviewed from the operative notes.

Results: Three various anatomic types of brachial fossa veins were recognized. The most common was multiple or M formation (median cephalic vein joining with median basilic vein and presence of median vein of forearm between cephalic and basilic veins) which was found in 159 patients (81.1%). The other 2 types were less common: single vein (median cubital vein) across brachial fossa joining between cephalic and basilic veins and absence of median vein of forearm in 10 (5.1%) and no joining vein between cephalic and basilic veins in brachial fossa and absence of median vein of forearm in 27 (13.8%). Out of 196 patients, 177 (90.3%) had perforating veins.

Conclusion: Multiple or M formation (median cephalic vein joining with median basilic vein and presence of median vein of forearm) was the most common venous pattern in brachial fossa of the patients undergoing AVF construction. The perforating vein was also commonly found. The surgeon should recognize these venous anatomic variations and be cautious during the operation.

Keywords: arteriovenous fistula, brachial fossa, antecubital vein

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บทคัดย่อ

กายวิภาคศาสตร์ของหลอดเลือดดำใน brachial fossa ระหว่างการผ่าตัดทำ arteriovenous fistula

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วัตถุประสงค์: เพื่อศึกษารูปแบบของหลอดเลือดดำที่แขนพับในกลุ่มผู้ป่วยที่เข้ารับการผ่าตัดทำ arteriovenous fistula

วิธีดำเนินการวิจัย: การวิจัยนี้เป็นการวิจัยเชิงพรรณนา แบบเก็บข้อมูลย้อนหลังจากภาพที่เขียนบรรยายไว้ในระหว่างการผ่าตัด arteriovenous fistula ที่แขนพับ ในผู้ป่วยไตวายระยะสุดท้ายจำนวน 196 รายที่ส่งมาผ่าตัดที่ ภาควิชาศัลยศาสตร์ คณะแพทยศาสตร์วชิรพยาบาล มหาวิทยาลัยกรุงเทพมหานคร ตั้งแต่เดือนกุมภาพันธ์ พ.ศ. 2548 ถึงเดือนเมษายน พ.ศ. 2553 โดยศึกษาลักษณะทางกายวิภาคของหลอดเลือดดำในบริเวณแขนพับแบบต่าง ๆ และลักษณะทางกายวิภาคของตำแหน่งหลอดเลือดดำเชื่อมต่อ (perforating vein)

ผลการวิจัย: ลักษณะกายวิภาคของหลอดเลือดดำมี 3 แบบ แบบที่พบได้บ่อยที่สุด คือ มีหลอดเลือดดำ median cephalic และ median basilic เชื่อมต่อกันตรงกลาง และมีหลอดเลือดดำ median vein of forearm มีจำนวน 159 ราย (ร้อยละ 81.1) อีก 2 แบบได้แก่ แบบที่มีหลอดเลือดดำ median cubital vein เพียงหลอดเลือดเดียวที่พาดผ่านแขนพับ เชื่อมระหว่างหลอดเลือดดำ cephalic และ basilic โดยไม่มีหลอดเลือด median vein of forearm มีจำนวน 10 ราย (ร้อยละ 5.1) และแบบที่ไม่มีหลอดเลือดดำเชื่อมต่อระหว่างหลอดเลือดดำ cephalic และ basilic พาดผ่านแขนพับ และไม่มีหลอดเลือด median vein of forearm มีจำนวน 27 ราย (ร้อยละ 13.8) จากผู้ป่วยจำนวน 196 รายพบหลอดเลือดดำเชื่อมต่อ (perforating vein) ใน 177 ราย (ร้อยละ 90.3)

สรุป: ลักษณะกายวิภาคของหลอดเลือดดำบริเวณแขนพับที่พบบ่อยที่สุด คือแบบที่มีหลอดเลือดดำ median cephalic และ median basilic เชื่อมต่อกันตรงกลาง และมีหลอดเลือดดำ median vein of forearm และหลอดเลือดดำเชื่อมต่อก็พบได้บ่อยในบริเวณแขนพับนี้ ดังนั้น ศัลยแพทย์จึงควรตระหนักและมีความระมัดระวังระหว่างผ่าตัด

Introduction

Arteriovenous fistula (AVF) is a common technique for creating vascular access for patients with end-stage renal disease (ESRD). Superficial veins in the upper extremities, particularly the antecubital veins, are used for an anastomosis between the adjacent arteries and veins. Surgical site on the snuffbox or in the wrist is generally the most common surgical site followed by the brachial fossa.

Cephalic vein over the wrist is the best native vein chosen as a conduit for AVF[1-3]. The patency rates were as high as 90% during the first year after the procedure[4], and slightly declined to 50-80% during the

following 2-5 years[5-8]. The technique commonly recommended is to anastomose the radial artery and the cephalic vein over the wrist[1,5]. However, the success of wrist arteriovenous formation is sometimes limited due to a presence of thrombophlebitis and fibrosis caused by previous parenteral drug administration. In these events, AVF construction over the brachial fossa is an alternative option. Joining vein between cephalic and basilic vein is generally used as the best native vein chosen as a conduit for AVF in the brachial fossa.

Previous studies, including one from our institution, reported that 42.6-68.8% of all AVF construction procedures were performed in brachial fossa[9,10]. Approximately 93% of them were achieved with AVF maturation. Conventionally, the venous system in the brachial fossa was classified into 2 main patterns: one or multiple cubital veins across the fossa. The latter is known as an M-formation[11]. Nevertheless, one observation from our previous study[9] and other reports[1-6] was a variation of venous anatomy especially the joining veins in the brachial fossa. This variation is more commonly found than that encountered in the wrist.

The anatomic variation of the joining veins certainly cause operative difficulties and associated complications. In order to avoid or minimize the inadvertent injury to the vein during an AVF construction, recognition of any anatomic variations of veins in the brachial fossa is crucial. The objectives of this study were to determine the various anatomic forms of antecubital vein and presence of any perforating vein in the brachial fossa.

Methods

The study obtained an approval from the Ethics Committee for Research involving Human Subjects of the institution. All ESRD patients who were consulted to the Department of Surgery from February 2005 to April 2010 for AVF construction were identified. Inclusion criteria were the patients, regardless of age and gender, who had AVF construction over the brachial fossa in the institution and had complete operative description together with illustration of the venous anatomy in the brachial fossa.

The procedures of AVF construction were generally conducted as the followings. Pre-operative testing of venous patency and clear course of drainage of both arms was done by a tourniquet to select a more appropriate side. A transverse incision was made 1.5-2 cm distal to the elbow crease. Searching for the cephalic vein and brachial artery was performed by exploring the subcutaneous tissue at least 3 cm around the surgical incision. The anatomy and figures of these antecubital arteries and veins was drawing-illustrated together with the description in the operative note. Soft tissue in the surgical area was dissected to identify the cephalic, basilic and the median cubital veins as well as their perforating branches (Fig. 1). The bicipital aponeurosis was incised to expose the brachial artery and its associated deep vein. The venous limb was followed 1-2 cm above the crease to ensure that all deep veins or their main branches were ligated. The anastomosis may be achieved by either side-to-side or end-to-side patterns. After the operation, all patients were scheduled for follow-up visits at the first week, first month and then every 3 months thereafter. A patency of the fistula as well as edema of the forearm was assessed.

Data collected were: pattern of AVF anastomosis, various anatomic locations of veins in the brachial fossa, number and sites of perforating veins, presence of post-operative edema at 1 week and 1 month.

Results

Two hundred and three patients were identified during the study period. Seven were excluded due to

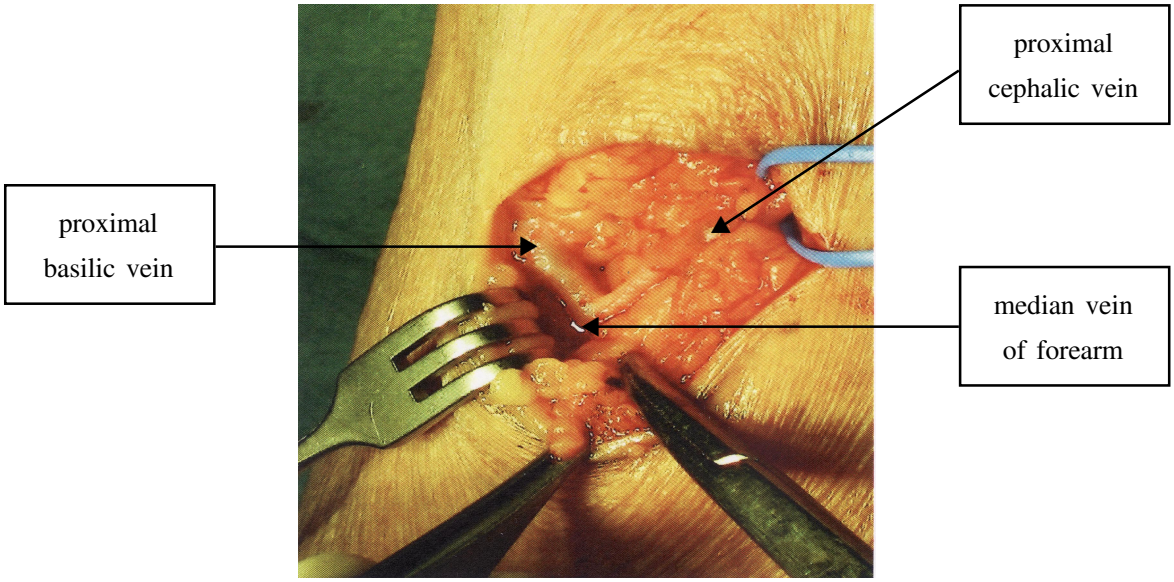


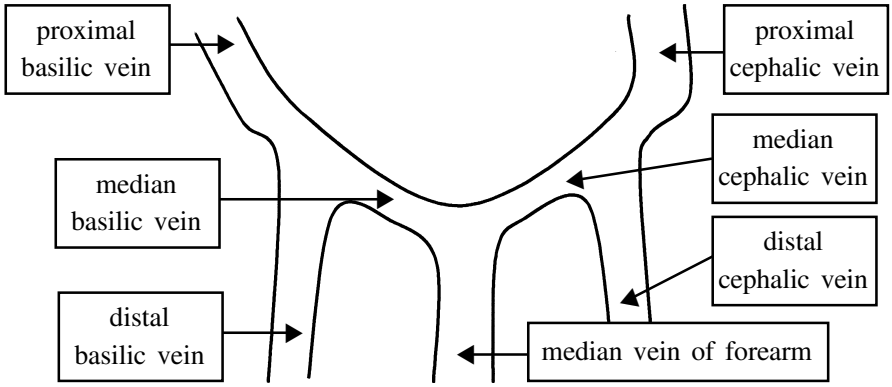
Fig. 1 Transverse incision 1.5-2 cm distal to the elbow crease exposing venous pattern of the brachial fossa

incomplete operative illustration of venous pattern. From the 196 ESRD patients included in the study, we found 3 anatomic venous patterns in the brachial fossa: multiple or M-formation (median cephalic vein joining with median basilic vein and presence of median vein of forearm between cephalic and basilic veins) in 159 patients (81.1%) (Fig. 2), single vein (median cubital vein) across brachial fossa joining between cephalic and basilic vein and absence of median vein of forearm in 10 (5.1%) (Fig. 3), and no joining vein between cephalic and basilic veins in brachial fossa and absence of median vein of forearm in 27 patients (13.8%) (Fig. 4).

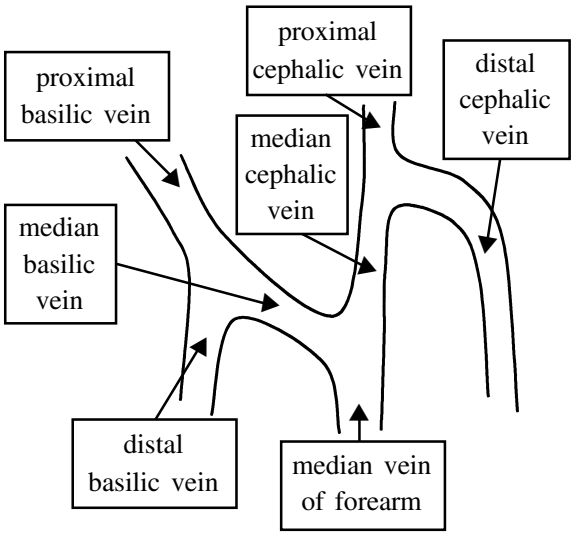
Among the 159 patients with M-formation, 3 variants were identified based on the levels of median cephalic and median basilic veins (Fig. 2). Symmetrical M-formation when the two veins were in the same level and asymmetry (high cephalic or high basilic) if one was higher than the other. We found symmetrical M-formation more commonly than the asymmetrical patterns: 134 patients (84.3%) compared to 25 patients (15.7%) respectively. Among the 10 patients with single vein across brachial fossa, 2 variants were found based on the levels of cephalic and basilic veins: high cephalic or high basilic (Fig. 3). We found equally distribution of the two patterns (5 patients in each group). One of the joining veins (median cephalic, median basilic or median cubital verin) in all 169 patients was used for an AVF. In 27 patients whose joining veins could not be identified despite the best attempt by extending the incision, the distant cephalic vein was used for the AVF.

Out of 196 patients, we found that 177 had perforating vein (90.3%). Among these 177 patients, 19 patients had 2 perforating veins, while the rest had only 1 perforating vein. Six various anatomical patterns of perforating veins were categorized according to its connection with the following veins: median vein of forearm in 77 patients (39.3%), median cephalic vein in 52 (26.5%), median basilic vein in 25 (12.8%), cephalic vein in 19 (9.7%), median cubital vein in 8 (4.1%), distal cephalic vein in 6 (3.1%), and proximal cephalic vein in 4 (2.0%). Of note, perforating veins in 5 patients (2.6%) was identified in M-structure, running superficially 2-3 cm before their perforation into the deep venous system.

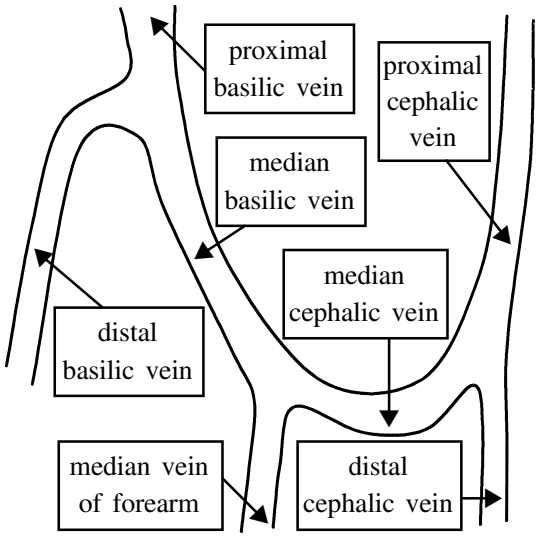
Aside from the 3 major venous patterns, 18 patients had other minor anatomic variations. These were:



A. Symmetrical M-formation



B. Asymmetrical M-formation-high lying cephalic

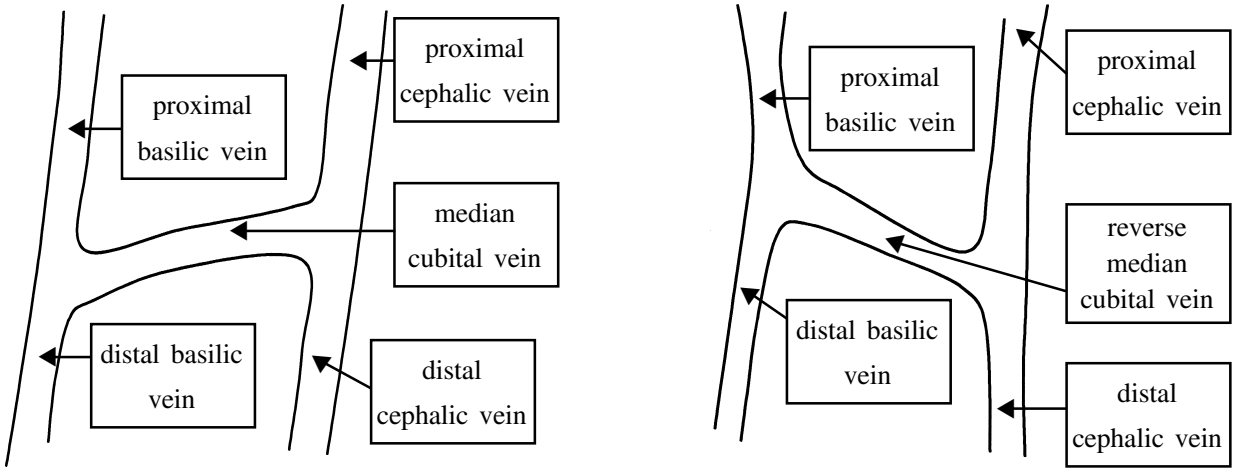


C. Asymmetrical M-formation-high lying basilic

Fig. 2 Venous pattern of brachial fossa: multiple (M)-formation (median cephalic vein joining with median basilic vein and presence of median vein of forearm)

double median cephalic vein in 5 patients, double cephalic vein in 5 patients, double median vein of forearm in 2 patients, congenital hypoplasia of median cephalic vein (smaller than 0.5 mm without fibrosis) in 4 patients, and abnormal vein connection from proximal basilic vein to proximal cephalic vein in 2 patients.

The arterio-venous anastomoses were performed as side-to-side in 181 patients (92.3%) and end-to-side in the other 15 patients (7.7%). Postoperative edema occurred in 7 patients (3.6%) whose condition was subsided after 1 month with conservative management. To be noted, all cases (100%) were the patients whose perforating vein could not be found.



A. High cephalic B. High basilic

Fig. 3 Venous pattern of brachial fossa: single vein across brachial fossa (median cubital vein) and absence of median vein of forearm

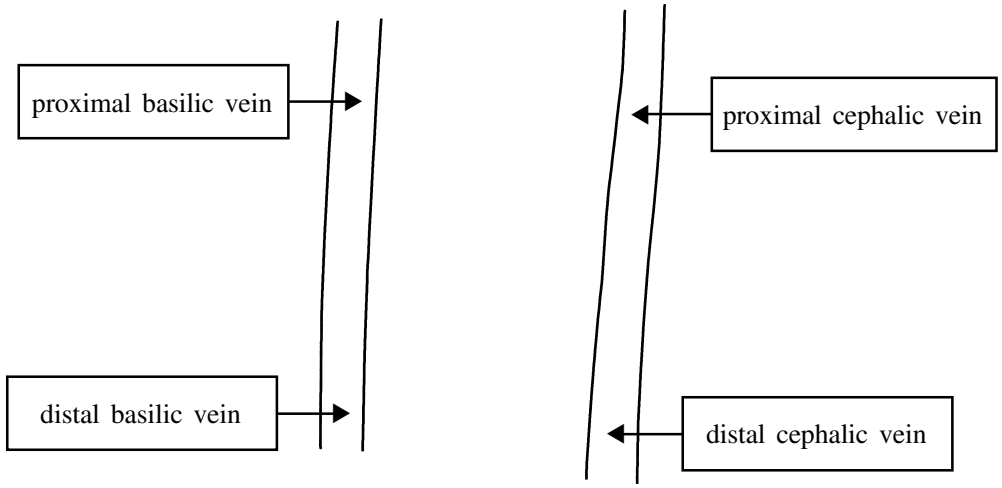


Fig. 4 Venous pattern of brachial fossa: no joining vein between cephalic and basilic veins in brachial fossa and absence of median vein of forearm

Discussion

Venous drainage track of the forearm starts from the median vein of forearm which drains subcutaneous tissue of the wrist upward and divides into 2 branches of cephalic and basilic veins. These 2 veins lie in the brachial fossa. This fossa is a triangular area located between the pronator teres, brachioradialis, and an imaginary line joining the humeral epicondyles. These 2 cephalic and basilic veins generally have inter-connect-

ing or joining vein in between. This joining vein is usually the venipucture site to obtain blood sample, without any important physiologic function in normal individual. Nevertheless, it is crucial for the success of the AVF procedure for a dialysis in an ESRD patient.

Previous studies reported that a single joining vein was more common in brachial fossa than the M-formation: approximately 80% or higher vs 2.9-20%, respectively.[11,12] We had different finding that the M-formation was more commonly found in our study or as high as 80%. We do not know whether ethnic or racial background of the population studied will have influence on these venous patterns until more studies can confirm our observation. In the mean time, this finding should alert any surgeon to be aware of this venous pattern.

The perforating vein is another structure, probably assisting in the venous drainage system in brachial fossa. However, its existence and clinical importance is rarely mentioned. Theoretically, its presence will allow an alternative arterio-venous shunting track in the deeper tissue, so it needs to be ligated to ascertain the optimal function of superficial arterio-venous structure or else the success rate of the AVF will be deteriorated. One previous study prospectively compared the flow of superficial AVF between those who had perforating vein clamping or no clamping.[13] The authors of that study found that clamping of perforating vein significantly increased radial artery pressure compared to the other group. This, in turn, increased a considerable amount of flow from the side-to-side AVF or increase an access of the superficial veins. Our study found perforating vein as a very common venous structure in this area or as high as 90%. This finding probably supported the success rate of the AVF procedure in our previous report which was as high as over 90%.[9]

Nevertheless, the benefit from the perforating vein ligation was accompanied by minor disadvantage. Our study found approximately 4% of edema. All of this event occurred in the patients whose perforating vein could not be found. Previous study by Suwichatkul et al[10] who reported patterns of AVF procedure found higher incidence of forearm edema (6.9%). Only the type of AVF was found as the cause of edema; higher rate was found in the side-to-side anastomosis than that of the end-to-side anastomosis, 12.2% vs 1.9%.[10] However, the authors did not mention whether they had ligated the perforating vein or not. Out of 196 patients, we could not find perforating vein only in 19 cases. Seven of them developed edema (36.8%). This event might be the result of failure to detect and to ligate the perforating vein. Therefore, we would like to emphasize the important role of perforating vein ligation.

Our study had some limitations. The area of dissection was relatively small, which might potentially missed some veins.

In conclusion, multiple or M formation (median cephalic vein joining with median basilic vein and presence of median vein of forearm) was the most common venous pattern in brachial fossa of the patients undergoing AVF construction. The perforating vein was also very common in this area.

Acknowledgment

We would like to thank Dr. Prayooth Siriwong, Head of the Department of Surgery, Faculty of Medicine Vajira Hospital, University of Bangkok Metropolis for his support in our study.

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