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# Femoral Vein Morphometry in Children

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## Abstract

**Introduction:** Central venous catheterization is normally performed in the superior vena cava system; however, the femoral vein is an option in cardiorespiratory resuscitation and compression or thrombosis of the superior vena cava system. Knowledge of the anatomy of the femoral vein will allow for a safer puncture.

**Objective:** to compare the femoral vein morphometry parameters of children, in the supine position and the position with external rotation, hip flexion, abduction, and thigh flexion (frog position).

**Materials and Methods:** Cross-sectional observational study using ultrasound to analyze the morphometry of the femoral vein in the supine and frog position. Patients in the radiology sector of the pediatric hospital who would undergo ultrasound were included and consented to participate in the study.

**Results:** Ninety-one patients were included with a mean age of 9.6 years. The cross-sectional area of the femoral vein was 47.6 $cm^2$ on the left side and 42.2 $cm^2$ on the right. This area increased to 79.9 on the left side and 74.6 on the right ($p<0.01$) in the frog position. The mean distance from the femoral vein to the skin was 15 mm on the left side and 14 mm on the right. In frogs, this distance decreased to 13 and 12, respectively, ($p<0.01$).

**Conclusion:** The frog position allows for a larger sectional area, and less depth of the femoral vein, thus facilitating the puncture of the femoral vein.

**Keywords: Central venous catheterization; Femoral vein; Ultrasound; Frog position; Morphometry**

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## Introduction

Central venous catheters are widely used in hospital practice; they are used in patients in need of hemodialysis, in surgical emergencies, admitted to the Intensive Care Unit (ICU), in chemotherapy, and for parenteral nutrition, in addition to being of vital importance during surgeries. They also provide safer venous access, allow the administration of drugs that can damage tissue, and allow monitoring of central venous pressure and collection of blood samples. Contraindications for central venous access are infections at the puncture site, thrombosis, and coagulopathies [1]. There are several complications related to central catheterization: Pneumothorax, arterial injury, nerve injury, gas embolism, cardiac tamponade, and catheter obstruction, among others [2]. Better anatomical knowledge of the vein to be punctured can minimize these complications.

In newborns and children hospitalized in critical condition in intensive care units, central venous access is an almost indispensable device due to the fragility of the venous network and the difficulty of maintaining peripheral venous catheterization for a long period. PICC (Peripherally Inserted Central Catheter) is the most commonly used central venous access in neonates in the United States [3].

A relevant issue when performing a central venous access procedure is the choice of venipuncture site. The first choice is usually through the superior vena cava system: Internal jugular veins and subclavian veins. However, puncture through branches of the inferior vena cava such as the femoral vein can also be performed, for example, in superior vena cava syndrome, thrombosis of tributaries of the superior vena cava system, cervical and thoracic burns, and infections at the insertion site of the upper site. Also, during cardiorespiratory resuscitation, femoral access will not interfere with resuscitation maneuvers [4].

The Femoral Vein (FV) has some characteristics that facilitate catheterization: it is superficial, it can be manually compressed, the surgical access is easy, the rate of immediate complications is low, and it allows the passage of large-caliber catheters [5].

The ultrasound-guided central venous access allows the identification of arteries, veins, and adjacent structures, making the procedure safer [6]. Furthermore, it is useful for providing information about the FV's size, depth, and course [7]. Figure 1 highlights how the anatomy of the femoral region will be seen in the Ultrasonography (USG), from medial to lateral "vein, artery and nerve". However, it must be remembered that the positions of the femoral vein and artery have many anatomical variations. In this way, the visualization of the structures by the USG makes the procedure safer. The need for training and the learning curve may be factors that contribute to the variability of the results found. There are sufficient arguments to recommend its use in venous access in children as a first choice. Thus, the need for USG as part of the study of FV morphometry in pediatric patients is evident [8].

Thus, a better knowledge of the morphometry of the FV (diameter and depth) and the study of its superposition to the Femoral Artery (FA) can help to determine the distance at which the needle should be introduced in the femoral puncture and avoid complications. Thus, it is extremely important to know the better position of femoral puncture. This subject is little discussed in the medical literature.

## Materials and Methods

The study was observational, and cross-sectional, using USG to analyze the morphometry of the femoral vein to improve the performance of central venous puncture. The sample size was 91 patients and the project was carried out in the Diagnostic Imaging Department of the Barretos Pediatric Cancer Hospital, from April 2016 to March 2017. The patients included in the study were aged up to 17 years and 6 months and had the consent form signed. These were submitted to ultrasonography in the inguinal region, in the radiology sector. The cross-sectional image of the femoral vein at the level of the inguinal ligament, on the patient's right and left sides, was stored in a digital file in the US system. Subsequently, the images were analyzed by the researcher, obtaining the following data: Latero-lateral and anteroposterior diameters of the femoral veins and arteries on both sides and in two positions, dorsal decubitus and frog position (external rotation, hip flexion, abduction, and thigh flexion). The calculation of the area was based on the two diameters. Also, the distance from the skin to the Femoral Vein (skin-VF) and the superposition of the arteries over the femoral veins. The overlap of the artery over the vein was classified as follows: No overlap, ≤ 50%, and >50%. The overlapping criterion was the artery surpassing the edge of the vein. And whether or not it reaches the midpoint of the vein in the lateral-lateral direction.

Inclusion criteria were outpatients up to 18 years of age, in any treatment phase, who agreed to participate in the study. Patients who were indicated to undergo radiology exams, mainly USG, were also included in the study. Exclusion criteria were patients who refused to participate in the study, had an expansive lesion in the region of analysis described in the medical records, and had an altered venous system: Lower limb edema, inguinal or retroperitoneal lymphadenopathy, vascular malformations, and lymphedema.

The recruitment of patients included in the research was in the radiology sector of the Children's Hospital. That is those patients who were already in the radiology sector and were invited to participate in the research.

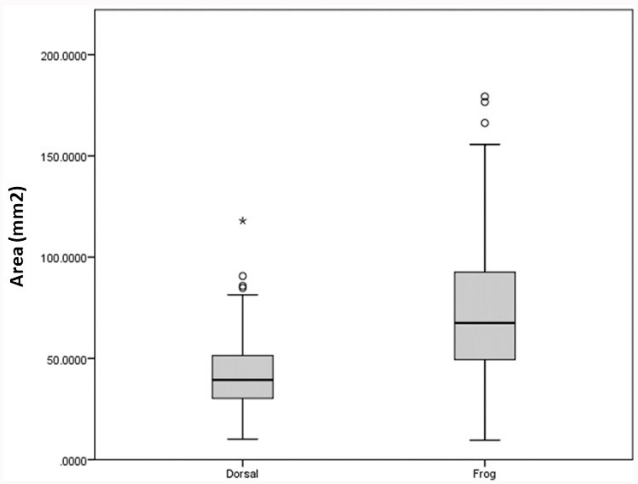
## Results

The final sample consisted of 91 patients, 51 male and 40 female. The mean age was 9.6 years, ranging from 0.13 to 17.57 years. The weight ranged from 4.44 kg to 93.85 kg and the average height was 145.97 cm. The mean area of the femoral vein was 42.28 $mm^2$ on the right side and 47.66 $mm^2$ on the left side in the supine position with the legs extended an area that increased to 74.24 and 79.99 $mm^2$, respectively in the frog position. This area increase had a statistical significance ($p<0.001$) by the Wilcoxon test. The mean skin-to-vein distance was 14.47 mm on the right side and 15.20 mm on the left side in the supine position and there was a decrease in the frog position to 12.64 mm and 13.01 mm, respectively ($p<0.001$). Table 1 and Graphic 1, 2 demonstrate the results cited.

Regarding overlap (Table 2), 53.9% of patients in the dorsal position had some degree of overlap on the right side. In the frog position, this number decreased to 19.8%. On the left side, 51.6% of the patients had overlap in the dorsal position, decreasing to 27.5% in frogs.

## Discussion

The insertion of a percutaneous catheter in children is a challenge, as the vessels are smaller and the patients do not cooperate easily, making USG relevant to assist in this process. A survey carried out on the internal jugular vein in pediatric patients found the difficulty of a puncture due to anatomical factors. They investigated through USG the venous anatomy of children up to 6 years old and found that in 18% of them the anatomical abnormality was responsible for the difficulties and complications of the puncture. They concluded that determining the course of the vein with ultrasound reduced the



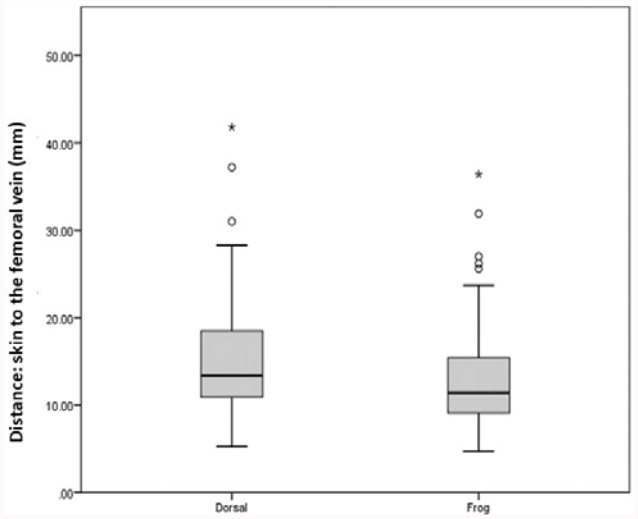

**Graphic 1:** Comparison between the areas of the femoral vein on the right side, in dorsal and frog position.

**Table 1:** Comparison of the mean area and distance from skin to vein in both positions and right and left sides.

| | Right side | Left side |
|---|---|---|
| Dorsal area ($mm^2$) | 42.28 | 47.66 |
| Frog area ($mm^2$) | 74.24 | 79.99 |
| Distance from skin to vein in dorsal position (mm) | 14.47 | 15.2 |
| Distance from skin to vein in frog position (mm) | 12.64 | 13.01 |

**Table 2:** Analysis of the overlap on both sides and in both positions.

| Position | overlap | Number of Patients | percentage |
|---|---|---|---|
| Dorsal Right Side | No | 42 | 46.20% |
| | <50 | 45 | 49.50% |
| | >50 | 4 | 4.40% |
| Dorsal Left Side | No | 44 | 48.40% |
| | <50 | 47 | 51.60% |
| | >50 | 0 | 0.00% |
| Frog Right Side | No | 73 | 80.20% |
| | <50 | 18 | 19.80% |
| | >50 | 0 | 0.00% |
| Frog Left Side | No | 66 | 72.50% |
| | <50 | 25 | 27.50% |
| | >50 | 0 | 0.00% |




**Graphic 2:** Comparison of the distance from the skin to the femoral vein on the left side, in the dorsal and frog position.

time and number of needle insertions required for the procedure. Furthermore, the chance of a puncture free of complications was high [9].

In the femoral vein puncture technique, the patient should be positioned in horizontal dorsal decubitus, with the thigh in slight external rotation. The Femoral Artery (FA) should be palpated and the needle inserted parallel to the FA, towards the umbilicus. To prevent inadvertent artery catheterization, palpation of the artery can be maintained while the needle is introduced into the vein [10]. After the catheter is fixed to the skin, an X-ray is taken to verify the position of its extremity, which must be located at the junction of the inferior vena cava with the right atrium or the height of the second lumbar vertebra, if the catheter length is not adequate enough to reach the central position [11]. Retroperitoneal hematoma and bowel injury may occur with insertion above the inguinal ligament. During use, femoral catheters can be easily obstructed by twisting in infants and children. Femoral vein catheterization is more prone to infectious complications and there is also a greater risk of thrombosis [5,11].

In this scenario, anatomical knowledge is really important to help central venous access, since in pediatric patients, in addition to the variability in size, there is an overlap of the FA over the FV and this can lead to complications such as arterial puncture and difficulties in venous access. Warkentine et al. [12] in their study with a group of children between 0 and 9 years old, found that FA totally overlaps FV in 8% and 4% partially overlapped [12,13].

According to Hind, there is a recommendation for the use of ultrasound in both adults and children to make catheterization faster, safer, and more effective [10]. USG-guided central venous access presents solid evidence for its use in punctures, as it increases the success rate and reduces the incidence of complications [10]. The use of USG ensures accurate target visualization, direct visualization of needle and guidewire progression, decreased puncture attempts, improved insertion success rates, minimized catheter-related complications, and reduced insertion time, especially in patients with difficult vascular access [1].

Verghese, in a study involving 95 children, obtained 100% success with the use of ultrasound and 76.9% with the traditional technique, with a reduction in the procedure time [8]. However, it is an operator-dependent method, requiring trained professionals. In addition, the USG device is not available in all hospitals.

Frog position is a more effective, viable, and reproducible method. The results of this study prove that there is an increase in the area of the femoral vein, its superficialization (Table 1), and a decrease in the overlap between the femoral arteries and veins (Table 2).

The study by Czyzewska et al. [14] evaluated the area of the femoral vein in the frog and dorsal positions, in adults aged between 19 and 39 years, totaling 205 patients. The results showed that in the dorsal position, the average area was 69.3 $mm^2$, and in the frog

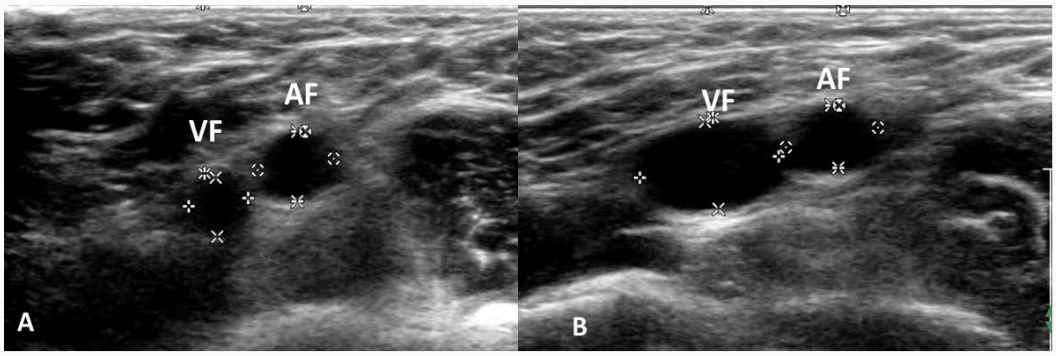



**Figure 1:** Ultrasonography images of femoral vessels. A: supine position. The same patient in frog position (B).
AF: Femoral Artery; VF: Femoral Vein

position, 114.7 $mm^2$. The above outcome was similar to this study, demonstrating an increase in the area of the femoral vein in the frog position. However, the difference is in the population recruited, one in adults and the other in children.

Hopkins et al. [15], also concluded in their 2009 research the increase in the total diameter of the femoral vein, the decrease in the overlap, and the decrease in the distance from the skin to the femoral vein in the frog position. Its sample has already been performed with children up to 9 years of age, totaling 84 patients. The difference in this study lies in the age range of the sample.

## Conclusion

A frog position is a safe option for central venous puncture of the femoral vein, as it increases the area of the femoral vein, reduces the distance from the skin to the femoral vein, and reduces the overlap between the femoral artery and vein. Thus, it should facilitate venipuncture of the femoral vein, assist professionals and minimize complications.

## Approval

This work was approved by NAP (Researcher Support Center) and CEP (Research Ethics Committee): 1285-2016.

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