

Bedside Ultrasonographically Assisted Femoral Vein Cannulation in Adult Population – A Hospital based Prospective Study

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A B S T R A C T

Introduction: Femoral Vascular cannulation is common practice in critical care, and is traditionally performed using the landmark technique - though failures and complications are not uncommon. In this regard, bedside ultrasound guided cannulation of femoral vein has been shown to improve the procedure success rate and reduce its associated complications. The aim of this prospective study was to identify safe location for femoral vein cannulation, using bedside ultrasonography, by studying the relationship of the femoral vein to femoral artery in femoral triangle.

Material and Methods: This is a hospital based observational study conducted on 406 patients attending emergency department of Vinayaka Mission's University Hospital. The subjects were made to lie down in supine position and examined in cannulating position (abduction, lateral rotation, mild flexion) and distance from the inguinal crease were marked at 0 cm, 2cm, and 5cm for both the limbs. While performing the ultrasound examination data sheet was filled adjacently containing the volunteer's name, age, gender and the relation of femoral vein to the artery at 0cm, 2cm, 5cm. Data analysis for frequency and proportions was carried using SPSS version 22.

Results: Of a total of 406 subjects, 400 above 21 years of age were included in final analysis. The relation of femoral vein to femoral artery in both the lower limbs was set at 0cm, 2cm, 5cm below the inguinal canal. Majority of the male subjects, 280(94.5%) in both the limbs and 88 (84.6%) of the female in right lower limb and 96 (92.3%) females in left lower limb showed 2cm medial to femoral artery as safe site for femoral vein cannulation using bedside ultrasonography.

Conclusion: The present study showed the safer location of femoral vein cannulation at 2cm medial to femoral artery using bedside ultrasonography in both males and females.

Keywords: Femoral Vein, Ultrasound, Vascular Access, Cannulation, Artery

INTRODUCTION

Central venous access, although usually easily obtained by the traditional external landmark techniques, can often present difficult situations.¹ Obesity, anatomical variations, venous insufficiency, edema, and clinical instability all pose unique problems. The risk of complications increases with each attempt, making a successful first attempt very important.² The femoral route is considered the easiest method of obtaining quick central venous access, because the IJV or SCV route are not only more technically demanding but also carry a higher possibility of life-threatening complications.³ These routes are also more difficult to access in bedridden patients. Although anatomical variations of the FV are rare,

iatrogenic complications such as hematomas make it difficult to locate the vein with precision by the landmark technique.⁴ Femoral vein access is also utilized in adult and paediatric critical care as well as anaesthesia, cardiac pacing, chemotherapy administration, and long-term dialysis. More over the femoral vein cannulation is considered easy compared to other central vein cannulations.⁵ However, it is not uncommon to have failed femoral cannulation. The use of ultrasound had minimized the rate of failures.⁶ Thus, USG guidance should ideally make FV catheterization far simpler and safer than the landmark technique, especially in the emergency setting. Many Indian emergency rooms do not have ultrasound, and cannulation is performed using blind techniques.

The guidelines used to approach the femoral vein is by palpating the arterial pulse and cannulating medial to the pulsation. However, there is no unique guidelines regarding the level at which the cannulation is safer. Femoral vein crosses femoral artery as it descends towards adductor canal. But in some subjects this crossing over takes place at higher level which resulted in arterial puncture and it can be complicated by hematoma formation, arterio-venous fistulas, pseudo-aneurysms, and hemorrhage.⁷⁻¹⁰

Although there are abundant data regarding the role of USG in improving outcomes with central venous catheter (CVC) insertion, the same has not yet been examined in sufficient detail for FV insertion. In this scenario, adopting real-time ultrasound-guided cannulation (UGC) of the femoral vein may potentially decrease adverse events. In recent years, several randomized controlled trials (RCTs) have been published evaluating the efficacy and safety of UGC in patients providing new insights within the context of new technologies and invasive procedures. However, these trials were mostly underpowered to assess major vascular complications as a primary outcome and relevant vascular-access-related complications during femoral vein catheterization remains unclear. Therefore, ultrasound-guided cannulation is still not used routinely for vascular access in the laboratory, and is also not recommended in statements or current guidelines for interventional vascular procedures. Hence, we have undertaken a prospective study to evaluate the safe level of cannulation using bedside ultrasound- in patients undergoing trans catheter diagnostic and interventional procedures

The aim of this prospective study was to identify safe location for femoral vein cannulation, using bedside ultrasonography, by studying the relationship of the femoral vein to femoral artery in femoral triangle.

MATERIAL AND METHODS

A hospital-based Observational study conducted for 14 months from June 2013 to August 2013 in Intensive care unit, emergency department, or operating rooms, as relevant to application of bedside ultrasound in Vinayaka Mission's University Hospital on patients attending OPD of Vinayaka Mission's University Hospital

Sample size determination: A total of 406 people aged 21 years and above were selected for the study of which 6 were excluded. Ultrasonographic assessments was done on the 400 volunteers.

Sampling technique: Convenience sampling

Inclusion criteria: older than 21 years of age and scheduled to undergo a diagnostic or interventional procedure via retrograde femoral vein were selected.

Exclusion criteria: Those who have undergone any procedures in femoral triangle, history of pelvic or lower limb injuries were excluded from the study.

Intervention: Bedside ultrasound by treating clinician

Data collection: The subjects were explained about the procedure and expressed consent was obtained. An emergency physician who is well trained in ultrasonographic assessment

of femoral vessels had done the procedure. A female staff nurse accompanied the patient when the assessment was done on female patients. The subjects were made to lie down in supine position and examined in cannulating position (abduction, lateral rotation, mild flexion) and distance from the inguinal crease were marked at 0 cm, 2cm, and 5cm. Similarly, examination was performed another limb also. A folded blanket was placed under the lateral aspect of lower thigh to make the volunteer comfortable.

Groin and upper part of thigh was exposed on the side of assessment. By using 7.5 MHz linear probe Right and left groins were examined with the minimum amount of pressure between the probe and skin in order to obtain an adequate image. The position of the inguinal ligament was defined by marking a straight line from pubic tubercle to anterior superior iliac spine. The vessels were located in the groin and then with the vessels in cross section, ultrasound images were obtained at the level of the inguinal ligament 0cm, 2 cm and 5 cm below it. Thick walled, circular vessel was considered femoral artery and thin walled, oval and collapsible vessel was considered femoral vein. When in doubt pulse wave mode was used to differentiate the vein and artery. Course of femoral vein was studied in relation to femoral artery from groin at 0cm, 2 cm and 5cm and the relation of vein to the artery was documented in a data sheet. While performing the ultrasound examination data sheet was filled adjacently containing the volunteer's name, age, gender and the relation of femoral vein to the artery at 0cm,2cm, 5cm. Only 3 types of relations (medial, posteromedial, posterior) were observed at those three levels.

STATISTICAL ANALYSIS

Data were collected and entered in excel sheet and statistical analysis was done. Descriptive analysis was carried out by frequency and proportion for categorical variables. No statistical tests were applied due to 0 subjects for a variable. IBM SPSS version 22 was used for statistical analysis.¹¹

RESULTS

A total of 400 subjects were included in the final analysis. Out of the total subjects there were 296 males and 104 females all above 21years of age. (Table 1)

The relation of femoral vein to femoral artery in both the lower limbs was set at 0cm, 2cm, 5cm below the inguinal canal. In general,368(92%) of the subjects have 2cm medial to femoral artery in right lower limb and 376(94%) in left lower limb as safe location for femoral vein cannulation. (Table 2)

Majority of the male subjects, 280(94.5%) showed the safe location at 2cm medial to femoral artery in right and left lower limb. (Table 3)

Out of 400, 88 (84.6%) of the female subjects in right lower

Gender	Summary N (%)
Male	296 (74%)
Female	104 (26%)
Age	32.3 ± 8.4 (21-83)

Table-1: Distribution of Gender in study population (N=400)

Parameter	Medial	Posteromedial	Posterior
Depicting the Relation of Femoral Vein to Femoral Artery in the right lower limb			
0cm (N=400)	400 (100%)	0 (0%)	0 (0%)
2cm (N=400)	368 (92%)	20 (5%)	12 (3%)
5cm (N=400)	56 (14%)	172 (43%)	172 (43%)
Depicting the Relation of Femoral Vein to Femoral Artery in the left lower limb			
0cm (N=400)	400 (100%)	0 (0%)	0 (0%)
2cm (N=400)	376 (94%)	12 (3%)	12 (3%)
5cm (N=400)	56 (14%)	172 (43%)	172 (43%)

Table-2: Frequency distribution depicting the Relation of Femoral Vein to Femoral Artery in the right and left lower limb (N=400)

Parameter	Medial	Posteromedial	Posterior
Depicting the Relation of Femoral Vein to Femoral Artery in the right lower limb for Male			
0cm (N=296)	296 (100%)	0 (0%)	0 (0%)
2cm (N=296)	280 (94.5%)	8 (2.7%)	8 (2.7%)
5cm (N=296)	52 (17.5%)	136 (45.9%)	108 (36.4%)
Depicting the Relation of Femoral Vein to Femoral Artery in the left lower limb for Male			
0cm (N=296)	296 (100%)	0 (0%)	0 (0%)
2cm (N=296)	280 (94.5%)	4 (1.3%)	12 (4.05%)
5cm (N=296)	52 (17.5%)	136 (45.9%)	108 (36.4%)

Table-3: Frequency distribution of depicting the Relation of Femoral Vein to Femoral Artery in the right and left lower limb in males (N=296)

Parameter	Medial	Posteromedial	Posterior
Depicting the Relation of Femoral Vein to Femoral Artery in the right lower limb for Female			
0cm (N=104)	104 (100%)	0 (0%)	0 (0%)
2cm (N=104)	88 (84.6%)	12 (11.5%)	4 (3.8%)
5cm (N=104)	4 (3.8%)	36 (34.6%)	64 (61.5%)
Depicting the Relation of Femoral Vein to Femoral Artery in the left lower limb for Female			
0cm (N=104)	104 (100%)	0 (0%)	0 (0%)
2cm (N=104)	96 (92.3%)	8 (7.6%)	0 (0%)
5cm (N=104)	4 (3.8%)	36 (34.6%)	64 (61.5%)

Table-4: Frequency distribution of depicting the Relation of Femoral Vein to Femoral Artery in the right and left lower limb in females (N= 104)

limb and 96 (92.3%) in left lower limb too showed 2cm medial to femoral artery as safe for femoral vein cannulation using bedside ultrasonograph. (Table4)

DISCUSSION

Our results showed the role of bedside ultrasonography by experienced clinicians for the cannulation of the femoral vein in adult population undergoing diagnostic and interventional procedures. Femoral vein catheterizations have been a preferred acute access because they were simple to perform and avoided unnecessary surgery. However, many studies were limited to internal jugular and subclavian (USG) and external landmark-guided group (ELT) venous cannulation and very few data are available regarding important technical aspects of successful femoral vein cannulation. A recent report demonstrated that venous anomalies in the femoral triangle are extremely rare and the most common cause of missing a patent femoral vein is that its course is deviated secondary to subcutaneous tissue fibrosis or haematoma pulling or pushing the vein away from its normal anatomical course.¹² Hence the present study was undertaken to check the efficacy of bedside

ultrasound for femoral vein cannulation in femoral triangle. In the case of femoral vein catheterization, ultrasound can aid in anatomic visualization. Within the triangle, the femoral vein is found medial to the common femoral artery. The insertion site is identified by locating the arterial pulsation 1–2 cm below the inguinal ligament within the femoral triangle.¹³ Because of the relatively constant location of the vein related to the artery (2–5 cm) closer to inguinal canal was considered as the measuring point in the present study. This finding of our study is in comparison to Hughes P et al¹⁴ where the distance was (2–4cm). This distance reduced puncture to femoral artery and is in accordance to US guidance where an 85% reduction in the rate of catheterization failure and an 86% reduction in arterial puncture rates was seen.¹⁵ The present study was conducted to reduce the complications of femoral vein cannulations in femoral triangle as there is some overlapping between the CFA and CFV in 65% of the patients; therefore, an arteriovenous fistula formation can occur if an inadvertent posterior wall perforation of the CFA occurs. To increase the lumen of the FV, subjects were laid in

supine position. this is in contrast to a study by Randall C et al¹⁷ where the Positioning of the leg in an abducted and externally rotated position helped to maximize the cross-sectional diameter of the femoral vein.

All the subjects 400 were cannulated and the findings were in contrast to a study by Brass P et al¹⁶ where, CVC placement in the FV, the use of US compared with the landmark technique increased the overall success rate (US, 134/150 (89.0%) vs landmark, 127/161 (78.9%); risk ratio (95% CI) 1.11 (1.00–1.23)) and the success rate with the first attempt (US, 91/107 (85.0%) vs landmark, 57/117 (48.7%); risk ratio (95% CI) 1.73 (1.34–2.22). this can be because the present study did not compare with landmark technique and did not check for risk ratio, success rates etc.

The major finding of the study was that majority of subjects 396(94%) showed 2cm medial to femoral artery as the safe location for femoral vein cannulation in both the limbs. Out of 296 males 280 (96%) in both the limbs showed 2cm medial to femoral artery whereas, out of 104 females 88 (94%) of them in right lower limb and 92(96%) of them in left lower limb showed the same result. The difference can be because of anatomical structures. As there are no much studies to correlate with our results, we compared this finding in paediatric population in a study conducted by Warkentine FH et al.¹⁸ Hence, we consider 2cm medial to femoral artery as the safe location for femoral vein cannulation followed by 5cms, using bedside ultrasonography.

LIMITATIONS AND RECOMMENDATIONS:

The major limitation is that, we did not analyse the total procedure time and attempts made because we believe it may not be exactly representative with the procedures being done by different operators in different clinical situations. Femoral artery puncture and other complications were not recorded in our study. Another limitation of the study is the small sample size and a single hospital-based study. Hence, we recommend further studies to be carried considering large sample, different hospitals in different geographical areas and different interventional procedures.

CONCLUSION

To conclude, bedside ultrasound-assisted cannulation of the femoral vein was associated with lower access-related complications. To avoid failed cannulation and arterial punctures in the femoral triangle, the results of the present study showed the safer location of femoral vein cannulation to be 2cm medial to femoral artery and below the inguinal ligament in both males and females.

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