Original Article

Ultrasound guided central venous cannulation in ICU: Retrospective analysis of a single center experience

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Abstract

Background and Aims: Central venous cannulation is a common procedure in intensive care unit. Use of ultrasound guidance can decrease complications and increase successful cannulations.

Methods: Patients who underwent ultrasound guided central venous cannulation over a duration of one year, in a single center, were analyzed retrospectively.

Results: A total of 101 patients were analyzed. Internal jugular vein was cannulated in 84 (83.2%) and femoral vein was cannulated in 17 (16.8%) patients. Cannulation was successful in all cases. Elective cannulation was performed in 80 (79.2%) of patients and emergency cannulation was performed in 21 (20.8%) patients. Platelet count was less than 50000/cu mm in 30 (29.7%) patients and prothrombin time was more than 13 seconds in 84 (83.2%) patients. Cannulation was successfully performed in first attempt in 99 (98%) patients. None of the patients had arterial puncture, major bleeding, pneumothorax, arrhythmias or catheter malposition. One patient developed hematoma at the catheter insertion site.

Conclusions: When performed by an experienced operator, ultrasound guidance can enhance safety and improve success for central venous cannulation.

Introduction

Central venous cannulation is a common procedure in intensive care unit (ICU). The common indications are for administration of vasopressors and inotropes, volume resuscitation, renal replacement therapy, total parenteral nutrition, etc. Cannulation might be performed under elective or emergency circumstances, depending on the indication.[1] Ultrasound guidance for central venous cannulation has been increasingly used in clinical practice

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and is recommended by various practice guidelines. When performed by properly trained clinician, use of ultrasound guidance improves cannulation success and reduces complications.[2,3] We performed a retrospective analysis of ultrasound guided central venous cannulation in ICU of a single center over a duration of one year.

Materials and Methods

The patients who had central venous cannulation performed in the ICU of Alka Hospital Pvt. Ltd., Lalitpur, Nepal, over the duration of one year (January 1, 2019 till December 31, 2019) were eligible for the study. The charts of the patients were analyzed retrospectively. All the procedures were performed by a single operator with the experience of over 500 ultrasound guided central venous cannulations. The procedures were performed with aseptic precautions and as per the standard recommendations and supplemented by a standard checklist.[4] The ultrasound probe used was a 6–10 L38 MHz linear transducer SonoSite turbo unit (SonoSite®, Micromaxx, Bothwell, WA, USA). All cannulations were performed with real time ultrasound guidance and with short-axis technique. Either the internal jugular vein or the femoral vein was cannulated as per the discern of the performing clinician. Either 7 French triple lumen central venous catheter or 10.5 French dialysis catheter was inserted as per the indication. The demographic characteristics of the patients, site of insertion of catheter, indication for central venous cannulation, platelet count and prothrombin time at the time of cannulation, size of catheter inserted, number of attempts for cannulation and any associated complications were documented. Any charts with incomplete documentation were excluded from the study.

Results

A total of 120 patients were eligible for the study. However, 19 were excluded due to incomplete documentations. Among the 101 patients enrolled, age ranged from 19 to 93 years with the mean age of 50 years. Of them, 52 patients (51.5%) were male and 49 (48.5%) were female. Internal jugular vein was cannulated in 84 (83.2%) and femoral vein was cannulated in 17 (16.8%) patients. Cannulation was successful in all cases. A total of 18 (17.8%) cannulations were for renal replacement therapy. Elective cannulation was performed in 80 (79.2%) patients and emergency cannulation was performed in 21 (20.8%) patients.

Platelet count was less than 50000/cu mm in 30 (29.7%) patients, between 50000 to 100000/ cu mm in 16 (15.8%) and was more than 100000/ cu mm in 55 (54.5%) patients (Table 1). Prothrombin time was more than 13 seconds (with 13 seconds as laboratory control) in 84 (83.2%) patients (Table 2). Cannulation was successfully performed in first attempt in 99 (98%) patients. Two patients (2%) required three attempts for cannulation. None of the patients had arterial puncture, major bleeding, pneumothorax, arrhythmias or catheter malposition. One patient developed hematoma at the catheter insertion site, which resolved with manual compression. This patient underwent emergency insertion of dialysis catheter at right femoral vein for refractory hyperkalemia, with serum potassium level of 7.2 mEq/L despite medical management. This patient had platelet count of 16000/cu mm due to sepsis. This patient also required 3 attempts for cannulation.

Table 1. Platelet count of patients

Platelet count (per cu mm)	Frequency (n)	Percentage (%)
< 50000	30	29.7
50000 - 100000	16	15.8
> 100000	55	54.5

Table2. Prothrombin time of patients

Prothrombin time (seconds)	Frequency (n)	Percentage (%)
≤ 13	17	16.8
> 13	84	83.2

Discussion

Use of ultrasound guidance for central venous cannulation helps to address the anatomical variability of position of internal jugular vein in relation to carotid artery.[1] This technique thus yields the success rate of 96 to 100% for cannulation and also helps to decrease the number of attempts for cannulation.[5] In our study, cannulation was successful in all patients, with first attempt success in 99 (98%) of cases. Central venous cannulation is associated with various complications like inadvertent arterial puncture, pneumothorax, hematoma formation, etc. Femoral venous cannulation can be associated with retroperitoneal bleeding, formation of pseudoaneurysm and development of arteriovenous fistula. Ultrasound guidance helps to significantly reduce the complications associated with vessel cannulation.[1]

In our study, none of the patients developed complications like arterial puncture or pneumothorax. One patient developed hematoma at the catheter insertion site. The patient required three attempts for cannulation and was coagulopathic. Reasonable threshold for platelet transfusion central venous catheterization is controversial. A target platelet count over 20000/ cu mm may be reasonable.[6] However, in the very patient, central venous catheterization could not be differed as the patient required urgent access for the management of refractory hyperkalemia. Significant proportion of our patients had coagulopathy. Platelet count was below 50000/ cu mm in 30 (29.7%) cases and prothrombin time was over 13 seconds in 84 (83.2%) patients. This was probably due to the larger number of patients with hematological illness and with liver disease, in our study. There is growing evidence mentioning that central venous cannulation can be safely performed even in coagulopathic patients without and increased risk of bleeding complications, more so, with the use of ultrasound guidance.[7,8]

Proper and safe use of ultrasound guidance for central venous cannulation requires formal training. The operator need to acquire skills related to ultrasound scanning, proper identification of anatomical structures, tracking the needle tip during needle insertion and vessel cannulation. Institutions and professional societies need to develop training curriculum and the clinicians need to demonstrate competency and skills relevant to clinical practice, for the safe use of ultrasound.[9] The study demonstrated effective use of ultrasound for central venous cannulation in our limited resource setting, when performed by an experienced operator.[10]

This study has several limitations. The study design was retrospective, raising the possibility of bias and incomplete documentations. It was a single center study and all the cannulations were performed by a single and highly experienced operator. The findings may not be generalizable to other settings. A well designed prospective multicentric study is desirable.

To conclude, ultrasound guided central venous cannulation, when performed by an experienced operator can enhance safety and improve success.

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