Original Article

Ultrasound guided emergency cannulation of internal jugular vein in coagulopathic adult patients – a prospective observational pilot study.

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Abstract

Aim: *This study aims to evaluate the safety of ultrasound guided emergency cannulation of internal jugular vein in coagulopathic adult patients.*

Methods: *Adult subjects admitted in the intensive care unit, undergoing emergency cannulation of internal jugular vein under real time ultrasonographic guidance with platelet count less than 50,000/cu mm and/or international normalized ratio (INR) more than 1.5 were enrolled. Major and minor complications during the procedure were noted.*

Results: *Internal jugular vein was successfully cannulated in all the patients. The mean INR of patients having minor complications (provided that platelet count > 50000) was found to be 3.07 with 95% confidence interval(CI) being 2.37-3.77. The mean platelet count of patients having minor complications (provided that the INR<1.5) was found to be 27428 with 95% CI being 19428-36000. There was a significant relationship between margin of safety and occurrence of minor complications (>7mm vs 7mm or less; p value 0.027). Number of attempts while performing internal jugular vein cannulation was associated with minor complications (mean 1.5 with CI 1.2-1.78 vs mean 1.08 with 95% CI 1.00-1.25; p value 0.023). No major complications were reported during the study regardless of platelet count, INR, margin of safety or number of attempts.*

Conclusions: *Emergency cannulation of internal jugular vein may be safely performed in coagulopathic adult patients under real-time ultrasound guidance when performed by an experienced physician.*

Key-words: *Central Venous Cannula (CVC), Coagulopathic Patient, Internal Jugular Vein, Point of Care Ultrasound (POCUS), Venous Cannulation.*

Introduction:

Central venous cannulas are important portals for vascular access and for the assessment of changes in intravascular volume. Central venous cannulas permit the rapid administration of fluids, insertion of pulmonary artery catheters (PACs) or central venous O_2 ($ScvO_2$) saturation monitoring, insertion of transvenous electrodes, monitoring of central venous pressure (CVP), and for treatment of venous air embolism.[1]

Developing nations lack the advanced blood banks and procurement of blood products in short time is not only challenging but is near impossible. However, with the advancement in health care and increase in life expectancy, sicker patients are being managed in intensive care units (ICUs). It is not uncommon for the treating physician to face a coagulopathic patient who needs urgent central venous cannulation, when there is little time to wait for blood products to correct coagulopathy.

Central vein cannulation in a critically ill patient with coagulopathy is a challenge to an anesthesiologist and intensivist due to increased risk of complications. The challenge of successfully cannulating the internal jugular vein with minimal complication is aided by the use of real time ultrasonography. G Ruesz have suggested that ultrasound guided CVC placement without routine correction of coagulation abnormalities may be safe in the ICU.[2]

Real time ultrasonography helps cannulation of central veins under direct visualization, thus reducing the chances of complications. Another advantage that USG cannulation offers is the visualization of vessels in hypotensive patients in whom carotid artery is difficult to palpate for landmark identification.[3]

With the advent of portable and affordable ultrasound

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machines, the availability and the possibility to procure ultrasound machine in ICUs of even the resource limited settings is becoming more realistic. The demand for blood products is ever increasing, making timely procurement of blood products to correct coagulopathy a bigger challenge in resource limited places. We planned this prospective observational study to evaluate the safety of ultrasound guided emergency cannulation of internal jugular vein in coagulopathic adult patients when there is inadequate time for correction of coagulopathy for safe cannulation and when the demand for central venous access appears to outweigh the risk.

Subjects and Methods:

Adult subjects admitted in the intensive care unit undergoing emergency cannulation of internal jugular vein under real time ultrasonographic guidance with platelet count less than 50,000/cu mm and/or international normalized ratio (INR) more than 1.5 were enrolled in the study after obtaining a written informed consent. Patients with coagulopathy and semi-emergent indication for central venous cannulation, when there is time for correction of coagulopathy, were excluded from study.

All patients had cannulation of the internal jugular performed using the Seldinger technique. Subjects were placed in a head down position with the head turned slightly to the side opposite to that of cannulation. The skin of the anterior and lateral neck was prepared using antiseptic solution and draped. The ultrasound probe used was a 6-10 L38 MHz linear transducer SonoSite turbo unit (SonoSite®, Micromaxx, Bothwell, WA, USA). The probe was covered with a sterile sheath and sterile ultrasound gel was applied to the inside of the sheath. Each cannulation was performed by an experienced anaesthesiologist with a minimum of 3 years of experience in cannulation of central veins and a minimum of 100 ultrasound guided cannulations of internal jugular vein. Following information were recorded: indication for central venous cannulation, platelet count, prothrombin time, INR, side of internal jugular vein cannulated, mechanical ventilation status of the patient, diameter of internal jugular vein (mm), margin of safety (mm), number of attempts, approach (short / long axis) and success of cannulation.

Margin of safety was the distance between midpoint of internal jugular vein and the lateral border of carotid artery. Diameter of internal jugular vein and margin of safety were measured at the same level and in the same head position of the patient as during cannulation.

A short axis image of the internal jugular vein was obtained by placing the transducer in a transverse orientation on the patient's neck at the level of the cricoid cartilage. The needle was inserted at 60 degrees to the vertical and advanced toward the vein employing gentle aspiration on the attached syringe. Entry to the vein was confirmed by visualizing indentation of the anterior wall of the vein followed by blood in the syringe and by visualising the tip of the needle inside the vein. Confirmation of guide wire placement was performed by scanning the vein in both short and long axis planes.

Complications if present were recorded and were categorized as major or minor. Complications like carotid puncture, carotid cannulation, pneumothorax, haemothorax, haemodynamically significant or life threatening bleeding and airway compromise attributable to bleeding were categorized as major complications. Superficial haematoma either visible or palpable and superficial oozing from cannula site were categorized as minor complications.

Results:

A total of 25 cases were enrolled in the study. Technical success was achieved in all the cases. The mean INR of patients having minor complications (provided that platelet count > 50000/cu mm) was found to be 3.07 with 95% CI of 2.37-3.77 (Table 1). The mean platelet count of patients having minor complications (provided that the INR<1.50) was found to be 27428/cu mm with 95% CI being 19428-36000/cu mm (Table 2). None of the patients had the combination of platelet count less than 50000/cu mm and INR more than 1.50. Margin of safety was found to be related to the occurrence of minor complications and the association was statistically significant (Table 3 and 4). Number of attempts for cannulation was found to be associated with the occurrence of minor complications and the association was statistically significant (Table 5 and 6). Major complications such as carotid puncture, pneumothorax, hemothorax, hemodynamically significant bleeding or airway compromise were not reported during the study regardless of platelet count, INR, safety of margin or number of attempts.

Discussion:

Cannulation of a large central vein is the standard clinical method for monitoring central venous pressure and is also performed for a number of additional therapeutic interventions, such as providing secure vascular access for the administration of vasoactive drugs or to initiate rapid fluid resuscitation. Frequently, the central venous location is the only site available for intravenous access.[4] Due to the spectrum of usage of the central venous catheter, its requirement is increasing in medical practice. Sometimes coagulation disorders are present in patients with indication of central venous cannulation. Coagulation disorders pose a challenge as there are increased chances of complications like hemorrhage from the insertion site, hematoma formation and hemothorax. Usually, correction of coagulopathy is sought before the procedure. However, it is unclear whether fresh frozen plasma (FFP), platelet concentrate or platelet rich plasma (PRP) should be administered prior to attempted catheterization when coagulopathy is not severe. Although correction of coagulopathy may be possible, it may not be beneficial, it may be impossible to administer the corrective transfusion factor owing to lack of venous access or the condition may not be correctable by transfusion alone.[5]

Each year several million units of fresh-frozen plasma (FFP) are transfused all over the world. Recent data demonstrate that annual FFP usage has been steadily rising. Much of the plasma that is administered is used for the purpose of correcting coagulopathy before performing an invasive

diagnostic procedure. This practice appears to be common despite the fact that most consensus guidelines do not recommend FFP for this indication when the coagulopathy is not severe. This practice exposes patients to the complications associated with transfusion of blood products and is costly. Furthermore, it promotes the use of pre-procedural laboratory testing, which also has costs and may unnecessarily delay the procedures. It can also lead to fluid overload in certain group of patients. The supposition underlying these transfusions is that even a mildly elevated INR is associated with excessive bleeding in the setting of an invasive procedure and that an intervention is needed for safety.[6] In our study we came across no major complication in any of the cases with coagulopathy. Occurrence of minor complications was significant when the INR was more than 3 in patients with platelet count more than 50,000.

The mean platelet count of patients having minor complications (provided that the INR<1.50) was found to be 27428 (95% CI: 19428-36000). In our study we found that minor complications were significant when the platelets count was below 27,000 in presence of normal INR. Doerfler et al also had similar results. They have mentioned that central venous cannulation can be done safely by a skilled clinician even in patients with hemostasis problems and complications were encountered only when the platelet count was below 6000.[7] Slichter et al suggested that attention should be focused on providing aggressive platelet therapy for active bleeding rather than transfusing platelets prophylactically. Therapeutic platelet transfusions have been documented to control bleeding, and mortality rates are not increased when comparing patients receiving therapeutic to that seen in patients receiving prophylactic platelet transfusions.[8] Zeidler et al have mentioned that the risk of non-severe bleeding was increased only in patients with platelet counts below 20000, but not with platelet counts between 20000 and 49000. They have suggested pre-procedural platelet transfusions only in patients with platelet counts below 20000.[9] Weigand et al have also concluded from their study that transfusion of blood products prior to CVC insertion is not necessary in most cases. A delay of CVC insertion waiting for blood products seems to be unjustified, particularly in view of complication rates.[10] Another study has concluded that ultrasound guided central venous cannulation in patients with liver disease and coagulopathy is a safe and is a highly successful modality. In their study, mean INR was 2.17 ± 1.16 whereas median platelet count was 149.5 (range 12-683) × 10^9/L. No major vascular or non-vascular complications were recorded in their patients.[11] Another study has also questioned the prophylactic plasma and platelet transfusion in the critically ill patient. They have suggested thromboelastometry based restrictive transfusion management may reduce unnecessary plasma and platelet transfusion, and might reduce the incidence of transfusion-related adverse events and transfusion-associated hospital costs.[12]

Availability of compact portable ultrasound has been a boon for the anesthesiologist/intensivist facilitating bed side ultrasonography by the non-radiologist. Point of care ultrasound (POCUS) is rapid, accurate, repeatable, inexpensive, noninvasive and without the risk of radiation and thus has became an extension of the clinical examination. The use of POCUS ranges from various bedside diagnostic utility to facilitate real time guidance for central venous cannulation.[13] Some studies show that despite a strong level of evidence and recommendations for using ultrasound guidance during CVC placement and availability of USG in all the units, only half of CVC insertions were ultrasound-guided. They concluded that compliance with this recommendation needs to be improved.[14] POCUS should be included in the teaching courses of residents in anesthesiology and critical care. On the basis of our study, the usual practice of pre-procedural correction of coagulopathy can be questioned. However, being a pilot study, our study has the limitation of enrolling only a small number of patients. Larger multi-centric studies need to be performed to test the validity of the findings of this small study.

To conclude, urgent central venous cannulation may be safely performed by an experienced anesthesiologist /intensivist using sonography in coagulopathic critically ill patients.

Tables:

Table 1. INR of patients having minor complications provided the platelet count is more than 50,000/cumm

		95% Confidence Interval	
		Lower	Upper
Mean	3.07	2.37	3.77
Median	2.90	2.10	4.20
Std. Deviation	1.06	0.46	1.21
Minimum	2.10		
Maximum	4.20		
Range	2.10		

Table 2. Platelet count of patients having minor complications provided the INR is less than 1.50

		95% Confidence Interval	
		Lower	Upper
Mean	27428.57	19428.57	36000.00
Median	24000.00	15000.00	40000.00
Std. Deviation	12380.86	7181.32	14466.71
Minimum	12000.00		
Maximum	40000.00		
Range	28000.00		

Table 3. Relationship between margin of safety and occurrence of minor complications:

			Minor Complications		Total
			No	Yes	
Margin of safety (mm)	≤ 7	Number of patients	4	9	13
		% within minor complications	30.8%	75.0%	52.0%
	> 7	Number of patients	9	3	12
		% within minor complications	69.2%	25.0%	48.0%

Table 4. Statistical significance between margin of safety and occurrence of minor complications:

	Value	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.891	0.027

Table 5. Relationship between number of attempts and occurrence of minor complications:

			Minor Complications		Total
			No	Yes	
Number of attempts	1	Number of patients	12	6	18
		% within minor complications	92.3%	50.0%	72.0%
	2	Number of patients	1	6	7
		% within minor complications	7.7%	50.0%	28.0%

Table 6. Statistical significance between number of attempts and occurrence of minor complications:

	Value	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.540	0.019

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None

Conflict of Interest:

None

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