Original Research Article

Comparison of ultrasound-guided internal jugular vein cannulation versus supraclavicular approach to brachiocephalic vein cannulation – A prospective, single-blind, randomized study

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Abstract

Background: Central venous catheterization plays a key role in patients that require immediate resuscitation, long-term fluid management, and invasive monitoring. Real-time, ultrasound-guided cannulation techniques have recently enabled fairly safe placements of central venous lines. Present study was aimed to compare ultrasound-guided internal jugular vein cannulation versus supraclavicular approach to brachiocephalic vein cannulation. **Material And Methods:** Present study was single-center, prospective, single-blind, randomized study, conducted in patients, age > 18 years, who required IJV catheterization, platelet count above 100,000 and normal coagulation profile. Patients were randomly allocated to Group IJV and group BCV for USG-guided CVC insertion. **Results:** In present study, 30 patients were studied in group IJV and group BCV each. Time for needle puncture (92.45 ± 51.57 sec vs 90.31 ± 49.29 sec) and Time for guidewire passage (50.14 ± 26.92 sec vs 51.38 ± 22.72 sec) were comparable in IJV and BCV group and difference was not statistically significant. While less time required for CVC insertion (192.37 ± 71.21 sec vs 154.41 ± 76.65 sec) and total CVC insertion time (379.18 ± 87.09 sec vs 291.54 ± 132.22 sec) was observed in BCV group as compared to IJV group and difference was statistically significant. In present study, successful canulations (96.67 % vs 100 %) and successful cannulations in first attempt (73.33 % vs 80 %) were comparable in IJV and BCV group. Difficulties such as redirections with needle required (1.37 ± 0.32 vs 1.19 ± 0.31), difficulty in guide wire passage (10 % vs 6.67 %), arrhythmia noted during CVC cannulation (23.33 % vs 16.67 %) were comparable in IJV and BCV group and difference was not statistically significant. **Conclusion:** Time required was significantly less in brachiocephalic vein cannulation as compared to internal jugular vein cannulation, which will be helpful in emergency situations.

Keywords: Ultrasound-guided, internal jugular vein cannulation, supraclavicular approach, brachiocephalic vein cannulation.

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INTRODUCTION

Central venous catheterization plays a key role in patients that require immediate resuscitation, long-term fluid management, and invasive monitoring. The remarkable increase in the use of central venous catheters (CVCs) has determined the need for a quick, safe and effective insertion procedure with no or minimal complications.[1] Thus, the choice of the cannulation technique is crucial for the success of the procedure. Despite frequent training and practice, central line placement is associated with complications such as pneumothorax, hemothorax, tracheal injury, air emboli, hydrothorax, chylothorax,

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catheter malpositioning, catheter-associated infection, thrombosis, arterial puncture, and even cardiac perforation.[2] The practice of using surface anatomy and palpation to identify target vessels before cannulation attempts (landmark technique) is based on the presumed location of the vessel, the identification of surface or skin anatomic landmarks, and blind insertion of the needle until blood is aspirated.[3] Real-time, ultrasound-guided cannulation techniques have recently enabled fairly safe placements of central venous lines.[4,5] Present study was aimed to compare ultrasound-guided internal jugular vein cannulation versus supraclavicular approach to brachiocephalic vein cannulation.

MATERIAL AND METHODS

Present study was single-center, prospective, single-blind, randomized study, conducted in Department of Anaesthesiology, at MGM Medical College and Hospital, NaviMumbai, India. Study duration was of One year (January 2020 to June 2021). Study approval was obtained from institutional ethical committee.

Inclusion criteria: Patients, age > 18 years, who required IJV catheterization, platelet count above 100,000 and normal coagulation profile, willing to participate in present study

Exclusion criteria: Patients with local or systemic infection, infection at cannulation site, known vascular abnormalities, untreated coagulopathy, Patient had a CVC catheter in the past 72 hours, Patient had cervical trauma with neck immobilisation

Study was explained to patients in local language and written consent was taken for participation and study. Patients were randomly allocated (by a computer-generated random-numbers table) into two groups of 30 patients each, as Group IJV and group BCV. Clinician who had more than five years of experience with USG-guided CVC performed all procedures. Monitoring consisted of pulse oximetry, electrocardiogram and non-invasive blood pressure for all patients. For patients on mechanical ventilation, the amount and extent of positive end-expiratory pressure (PEEP) was noted.

During procedure, patients were awake and spontaneously breathing. With the patient in the 30° Trendelenburg position, a shoulder roll was placed to extend the neck, which was rotated to left side to expose the puncture site. An 18-guage central venous catheter was used with Seldinger technique in both groups. The operators and their assistants were fully prepared and draped as per standard aseptic precautions.

In IJV group, internal jugular vein was located with the help of ultrasound 10 MHz probe. The skin was infiltrated with 1% lignocaine, the wheel of subcutaneous lignocaine was visualized with the ultrasound as an enlarging hypoechoic area. Vein was compressible, non-pulsatile, and distensible by the Trendelenburg position or the Valsalva manoeuvre. When the needle appeared to be in the vessel, evidenced by the ultrasound and the return of venous blood into the syringe, a guide-wire was placed through the needle into the vein and the needle was removed. A central venous catheter was placed over the wire and advanced into the IJV. In group BCV, USG probe was placed transversally on the neck to visualise the confluence of IJV, SCV, and BCV. The longitudinal view of BCV was obtained for cannulation, local anaesthesia was infiltrated at the insertion site and the vein was punctured with an 18-gauge needle to get flashback of dark venous blood in the syringe. The needle tip was visualised in-plane using USG and the guidewire was passed and its location was confirmed with USG. The vein was cannulated using Seldinger's technique, and the catheter was fixed the skin surface in all patients. Sterile dressing was applied after suturing the CVC catheter firmly in place. A chest X-ray was taken within one hour of procedure to document the final position of the catheter as well as to look for complications like pneumothorax. The access time, number of attempts till successful placement of catheter and complications were recorded. Complications, including arterial puncture, haematoma, haemothorax, irritation of brachial plexus and pneumothorax were recorded. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

RESULTS

In present study, 30 patients were studied in group IJV and group BCV each. Age, gender, BMI and ventilatory status of patients were comparable in both groups and difference was not statistically significant.

Table 1: General characteristics

	Group IJV No. of cases / Mean ± SD	Group BCV No. of cases / Mean ± SD	*P value*
Age (years)	50.3 ± 13.5	51.5 ± 13.0	0.81
Gender (Male: Female)	18:12	16:14	0.72
BMI (kg/m2)	22.91 ± 3.03	23.07 ± 2.9	0.79
Ventilation status (ventilated: non-ventilated)	21:9	20:10	0.87

Time for needle puncture (92.45 ± 51.57 sec vs 90.31 ± 49.29 sec) and Time for guidewire passage (50.14 ± 26.92 sec vs 51.38 ± 22.72 sec) were comparable in IJV and BCV group and difference was not statistically significant. While less time required for CVC insertion (192.37 ± 71.21 sec vs 154.41 ± 76.65 sec) and total CVC insertion time (379.18 ± 87.09 sec vs 291.54 ± 132.22 sec) was observed in BCV group as compared to IJV group and difference was statistically significant.

Table 2: Time required for CVC cannulation

	Group IJV (*n*=55)	Group BCV (*n*=55)	*P*
Time for needle puncture (seconds)	92.45 ± 51.57	90.31 ± 49.29	0.78
Time for guidewire passage (seconds)	50.14 ± 26.92	51.38 ± 22.72	0.69
Time for CVC insertion (seconds)	192.37 ± 71.21	154.41 ± 76.65	0.023
Total CVC time (seconds)	379.18 ± 87.09	291.54 ± 132.22	0.045

In present study, successful canulations (96.67 % vs 100 %) and successful cannulations in first attempt (73.33 % vs 80 %) were comparable in IJV and BCV group and difference was not statistically significant. Difficulties such as redirections with needle required (1.37 ± 0.32 vs 1.19 ± 0.31), difficulty in guide wire passage (10 % vs 6.67 %), arrhythmia noted during CVC cannulation (23.33 % vs 16.67 %) were comparable in IJV and BCV group and difference was not statistically significant. Among IJV and BCV group, 2 complications (1 hematoma and 1 arterial puncture) observed, which were managed conservatively.

Table 3: Success and complications of CVC cannulation

	Group IJV No. of cases (%) / Mean ± SD	Group BCV No. of cases (%) / Mean ± SD	*P*
Successful canulations	29 (96.67 %)	30 (100 %)	0.79
Successful canulations in First attempt	22 (73.33 %)	24 (80 %)	0.36
Redirections with needle required	1.37 ± 0.32	1.19 ± 0.31	0.45
Difficulty in guide wire passage	3 (10 %)	2 (6.67 %)	0.78
Arrhythmia noted during CVC cannulation	7 (23.33 %)	5 (16.67 %)	0.34
Complications			--
Haematoma	1 (3.33 %)	1 (3.33 %)	
Arterial puncture	1 (3.33 %)	1 (3.33 %)	

DISCUSSION

Cannulation of Internal Jugular Vein (IJV) is commonly performed to obtain venous access for procedures such as central venous pressure monitoring, the insertion of a pulmonary artery catheter, the administration of drugs such as vasopressors, inotropes, antibiotics, and chemotherapeutic agents as well as long-term administration of fluids, total parenteral nutrition and haemodialysis.[6] Complications of central venous catheterization include arterial puncture, hematoma, hemothorax, pneumothorax, arterial-venous fistula, air embolism, nerve injury, infections and thrombosis. Any serious complication including infections of central venous catheter adds a substantial amount to the cost of treatment making it a priority to minimize the incidence of any complications.[7] Success with insertion of central venous catheters also depends on the size of the internal jugular vein, the patient's blood volume, positioning, head rotation, pressure on the skin, and presence of trauma.[8] Strategies to minimize mechanical complications of central venous catheterization include proper knowledge of the anatomy, insertion by an experienced physician, limiting the number of attempts, proper selection of the route of central venous access, and use of ultrasound guidance. With the advent of USG, supraclavicular BCV cannulation is gaining interest due to the ease of cannulation with visualisation of the entire needle path with the help of USG, superficial location and no bone overlying the vein. In study by Gowda KY *et al.*,[9] success rate of cannulation was 98.5% in IJV group and 100% in group BCV (P = 0.31). The first attempt success rate was 76.3% and 81.81% in IJV and BCV group, respectively (P = 0.42). IJV was collapsed in 14.5% cases and BCV was collapsed in 0.9% cases. The needle visualization was better in BCV group (94.54%) compared to IJV (80%) (P = 0.02) group, which was statistically significant. The numbers of redirections of needle were more in IJV group. They concluded that, supraclavicular USG-guided in-plane BCV cannulation is a good alternative to USG-guided out-of-plane IJV cannulation, because of good caliber of the vein and better needle visualisation in the BCV group. Kunhahamed MO *et al.*,[10] noted that there were a 100% success rate (35/35) for cannulation in the USG group and a 91.4% success rate (32/35) in the AL (anatomical landmark) group. The catheter was placed on the first attempt in 17 (48.6%) patients in the AL group and 32 (91.4%) patients in the USG group. In AL group, there were three failed cannulation attempts in comparison to the USG group. The mean start to flash time for the AL technique was 16.59 s (±10.67) and 4.86 s (±2.18) in the USG group. The mean cannulation time was 305.88 s (±66.84) in the AL group and 293.03 s (±71.15) in the USG group. A total of seven acute complications were noted, of

which 2 (5.7%) in the USG group and 5 (14.3%) in the AL group. The real-time USG guided technique significantly reduces the number of attempts to cannulate, has a higher first-pass success rate, a quicker flash time, and fewer complications when compared to the AL technique. Suba O[11] compared central venous cannulation was done by conventional anatomical landmark guided technique versus USG guided central venous cannulation, both groups were comparable in terms of number of attempts, success or failure rate and complications of the procedure. Mean time taken for successful cannulation in Group A was 438 seconds and in Group B it was 224 seconds (p 0.004) which is statistically significant. Failure to successfully cannulate the IJV on an initial attempt may also increase risk of pneumothorax because of multiple needle passes or the increased difficulty encountered in performing the procedure may increase the subsequent risk of catheter associated bloodstream infection. Ultrasonographic guidance in central venous access has converted a blind procedure into a procedure under vision, reducing the complication rates markedly. The benefits of bedside US guidance for percutaneous CVC placement are thought to be due to the real-time visualization of the needle entry in the vein and relationship to surrounding structures. This leads to a reduction of failure rates in both first and total attempts at placement and complication rates decrease.[12,13] Studies conducted in anesthetic, cardiac, and intensive care settings have shown that real-time USG-guided central line placement, particularly through the internal jugular vein (IJV), can lead to a decrease in complications, and in some cases, a faster insertion time.[4,5]

CONCLUSION

Ultrasound-guided internal jugular vein cannulation versus supraclavicular approach to brachiocephalic vein cannulation were comparable with regards to success and complications of procedure. Time required was significantly less in brachiocephalic vein cannulation as compared to internal jugular vein cannulation, which will be helpful in emergency situations.

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