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ULTRASOUND GUIDED CENTRAL VENOUS CANNULATION BY ANESTHESIA TRAINEE: NEED OF THE HOUR DURING COVID PANDEMIC

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ABSTRACT Covid pandemic has created deficiency of doctors needed to administer skilled procedures in ICUs and operating rooms. Post graduate trainees need to acquire skills fast and perform it safely on patients. Ultrasound (USG)-guided central venous cannulation (CVC) is one such. The study aimed at finding the feasibility of training USG-guided CVC cannulation to anesthesia trainee as opposed to landmark method in terms of ease, speed and safety. Patients needing CVC were divided into 2 groups of 50 each, where Group 1 was subjected to Landmark method and Group 2 to USG-guided method. Continuous variables were compared using unpaired t test and categorical variables using either the Chi square test. Access time (in seconds) was significantly less in the USG group (258.78 ± 11.17) as opposed to Landmark technique (301.60 ± 14.03) (p 0.03). Accidental carotid artery puncture was seen in 9 patients in Landmark group as opposed to none in the USG group. No patient in any group developed pneumothorax. USG-guided technique is superior and safer than the traditional landmark technique in hands of anaesthesia trainee in terms of a shorter access time, and less incidence of arterial puncture which is desirable in COVID patients to shorten the exposure time. USG-guided method needs an assistant to focus the probe. Nonetheless, this training should be imparted to the trainee to fill the gap created by skilled doctors falling sick during COVID pandemic.

KEYWORDS : central venous cannulation, internal jugular vein, landmark, ultrasound

INTRODUCTION

COVID 19 pandemic has hit life's reset button leaving hardly any aspect untouched. Regular working of hospitals, medical education and training has been modified to meet the requirements of the 'new normal'. Central venous cannulation (CVC), which is a necessary skill acquired by every anaesthesia resident, was traditionally learnt by the landmark technique.

But it is gradually paving way for ultrasound-guided method since direct visualization by ultrasound (USG) makes the cannulation faster, easier and safer. [1,2] This transition in practice is a necessity now, since expertise in USG-guided central line insertion is more felt in times of COVID than ever before. Moreover, demand for CVC is more as patients are sick, needing mechanical ventilation and are being managed in prone position, often needing haemodialysis lines for renal failure. The recommendation has been to use the ultrasound guidance for central venous access, or even peripheral arterial catheter. [3,4]

Furthermore, a recent survey has put the number of doctors trained in critical care, emergency medicine, and pulmonology at a meagre 20000 in a population of 1.3 billion. [5] This, compounded by manpower crunch in the wake of health care professionals themselves falling prey to the infection necessitates that the young residents are trained in USG-guided central venous cannulation. It is paramount that expertise is attained fast to limit duration of exposure in COVID patients, avoid failed procedures in times of resource crunch, and achieve successful and quick cannulation in sick patients on organ support.

Whether a trainee can learn the technique and practice it safely in these dire times is something that is not yet explored. Hence, we bring to light a study conducted at our centre three years back, that explored feasibility, ease of learning and safety of USG-guided CVC as opposed to landmark technique in the hands of an anaesthesia trainee.

METHODS

After obtaining Institutional Ethics Committee approval and written informed consent from the participants or their relatives, we conducted this randomized, prospective observational study on patients requiring central venous cannulation at the Critical Care Unit (CCU) of our hospital. Adult patients of either sex, requiring central venous cannulation in the perioperative or post-operative period were included in the study. Those with anticipated difficult neck anatomy, coagulopathy, local site infection or any other contraindication to neck vein cannulation, or patients with haemodynamic instability were excluded from the study. The patients were randomly allocated into either Group 1 (Landmark Group) or Group 2 (Ultrasound Group) based on the random numbers generated by a web based programme (Research Randomizer https://www.randomizer.org/). The principal investigator enrolled the participants, and an anaesthesiologist not involved in the study assigned the intervention according to the random number table.

Central venous cannulation protocol

An experienced anaesthesiologist, skilled in both methods of central venous cannulation first trained the anaesthesia trainee, who then performed all central venous cannulations on the right internal jugular vein (RIJV) independently under supervision of the former.

Landmark Method Protocol

Patients were positioned supine with a shoulder pad to achieve extension of the neck. The procedure was performed by the performer (trainee) standing at the head end of bed. The head was turned slightly to opposite side of intended cannulation site. Under aseptic precautions, a 24 G locator needle was inserted at the apex of the triangle formed by the clavicle and the clavicular and sternal head of sternocle idomastoid muscle to locate the right internal jugular vein just lateral to the common carotid artery (Figure 1). A 5ml syringe filled with sterile saline was attached to the cannulation needle which was then inserted at the site of the finder needle and it was advanced in a sagittal plane 30° posterior and caudal towards the ipsilateral nipple at a 45° angle with the frontal plane and gently aspirated until there was free return of venous blood. After that, the guidewire was inserted and then a 10–12 cm long triple lumen CVC was inserted over the guidewire after dilatation using a dilator. After ensuring the proper position of catheter by aspirating venous blood through all three lumens and flushing with normal saline, the catheter was fixed. The patient was then returned to the supine position, and head and neck were placed in neutral position.

Figure 1: Relation of the two heads of sternocleidomastoid muscle and clavicle used in the Landmark technique

USG Guided Protocol

In the USG group, a 13-5 MHz linear array probe (Siemens Accuson X300, Siemens Medical Solutions, Malvern, PA, USA) was used to visualize the right IJV in the long as well as short axis. Confirmation of vein was done by compressibility as well as Doppler flow method. Venous puncture was done in short axis and finally confirmed in both the axes. Under all aseptic precautions, the assisting staff nurse held the USG probe on the neck of the patient in short axis such that carotid artery and internal jugular vein of same side were visualized on USG monitor (Figure 2). Skin puncture was then made by the performer with the help of cannula with a 5ml syringe containing normal saline which was further advanced towards IJV under continuous USG guidance until venous blood was aspirated in syringe. The syringe was detached, and guide wire was introduced through cannula and cannula was removed. A triple lumen central venous catheter was then threaded over guide wire after dilation and the guide wire was removed. After confirming the position of catheter by aspirating venous blood through all 3 lumens, the catheter was fixed with 3 skin stitches.

Final confirmation of placement of central venous catheter in vein was done with ultrasound immediately and by X-ray in PA view in both the groups to rule out accidental pneumothorax or any other complication.

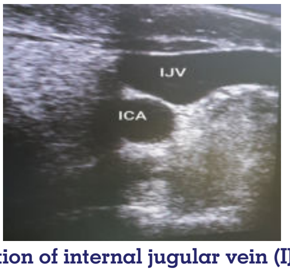

Figure 2: Relation of internal jugular vein (IJV) and internal carotid artery (ICA) as seen in ultrasound view

OBSERVATION

The data recorded included demographic profile (age, sex), haemodynamic parameters (Pulse rate, Blood Pressure, Oxygen saturation), the access time (defined as time from insertion of needle to aspiration of blood from catheter), number of skin punctures and any complications (inadvertent arterial puncture, subcutaneous emphysema, pneumothorax, hemothorax, procedural failure and desaturation).

Statistical Analysis:

Based on previous studies, the sample size was calculated taking the percentage of success rate as 94.4% in the landmark group and 100% in ultrasound guided group,[6] with an alpha error of 0.05 and power of study at 80% was 43 for each group. However, to adjust for dropouts a sample size of 50 in each group was considered. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc.2013, version 17.0 for Windows, Armonk, NY). Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as absolute numbers and percentage. Normality of distribution was compared using the Shapiro-Wilk test. Continuous variables were compared using unpaired t test (normally distributed data) and Mann-Whitney U test (not normally distributed variables). Categorical variables were analyzed using the Chi square test. For within the group comparisons, paired t test was used. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

Patient enrollment:

179 patients were consecutively enrolled of which 79 were excluded for not fitting inclusion criteria. Those fulfilling were randomly allocated to Group 1 or 2 (Fig 3).

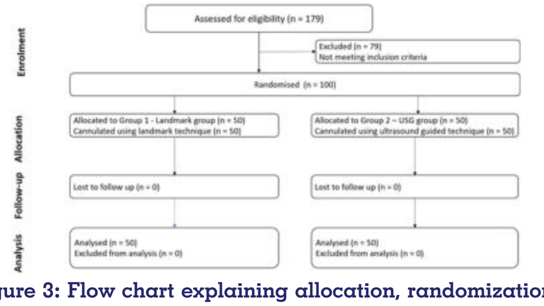

Figure 3: Flow chart explaining allocation, randomization, follow up and analysis of cases in the study

RESULTS

There were 50 patients in each group with the mean age of 48.02 ± 19.73 years in the Group 1 and 52.86 ± 19.14 years in Group 2 (p = 0.212). There were 34 females and 66 male participants in the study and the male to female ratio was also comparable between both the groups (p = 0.673, Table 1). There was no statistically significant difference in the haemodynamic parameters between both the groups or in the intra-group comparisons before, or after the procedure (Table 2). Access time was significantly lower in Group 2 (p=0.030), so also incidence of accidental carotid artery puncture (p=0.003) (Table 3).

Table 1: Demographic parameters

Parameter	Group 1 (n = 50)	Group 2 (n = 50)	p value
Age (in years)	48.02 ± 19.73	52.86 ± 19.14	0.212
Female	18 (36%)	16 (32%)	0.673

Group 1 = landmark group, Group 2 = ultrasound group. Variables expressed as numbers (n) and mean ± SD. A p value less than 0.05 was considered significant.

Table 2: Haemodynamic parameters inter-group comparison (before and after procedure)

Parameter		Group 1 (n = 50)	Group 2 (n = 50)	p value
Heart rate (beats/minute)	Before	107.2 ± 21.02	99.02 ± 23.13	0.067
	After	105.40 ± 18.83	99.52 ± 22.74	0.162
Systolic Blood Pressure (mm of Hg)	Before	113.56 ± 20.85	106.78 ± 17.76	0.083
	After	113.38 ± 20.93	111.12 ± 17.78	0.562
Diastolic Blood Pressure (mm of Hg)	Before	71.74 ± 16.14	69.12 ± 10.94	0.344
	After	71.72 ± 15.99	72.98 ± 12.86	0.312

Mean Arterial Pressure (mm of Hg)	Before	81.72 ± 15.24	81.67 ± 10.57	0.153
	After	82.12 ± 14.91	82.94 ± 12.48	0.23
Respiratory rate (per minute)	Before	20.66 ± 7.10	20.30 ± 4.00	0.755
	After	20.12 ± 5.81	18.52 ± 3.96	0.111
Oxygen saturation (%)	Before	97.02 ± 4.15	98.32 ± 2.39	0.114
	After	97.08 ± 4.15	98.44 ± 2.42	0.48

Group 1 = landmark group, Group 2 = ultrasound group. Variables expressed as numbers (n) and mean ± SD. A p value less than 0.05 was considered significant.

Table 3: Cannulation parameters

Parameter	Group 1 (n = 50)	Group 2 (n = 50)	p value
Access time (seconds)	301.60 ± 14.03	258.78 ± 11.17	0.030*
Number of successful cannulations (in 1st attempt)	37 (74)	38 (76)	0.051
Mean number of attempts	1.66 ± 1.29	1.48 ± 1.05	0.657
Number of cases requiring needle redirection (number)	22 (44.0)	20 (40.0)	0.685
Accidental carotid artery puncture (number)	9 (18.0)	0 (0)	0.003*
Desaturation (number)	0 (0)	0 (0)	1.000
Pneumothorax (number)	0 (0)	0 (0)	1.000

Group 1 = landmark group, Group 2 = ultrasound group. Variables expressed as numbers (n) and mean ± SD.

* p value less than 0.05 was considered significant.

DISCUSSION

The ultrasound guided technique has emerged as an alternative to the classical landmark technique.[6] While the majority studies have shown USG guided techniques to be safer as well as easier, question regarding experience of the operator remains unanswered.[2,6-9] The experience of an operator has been proven to have significant effect on CVC outcome.[10] The majority of studies comparing USG with landmark CVC employed operators having extensive experience as opposed to single anaesthesia trainee in our study.[2,6,9,11]. Haemodynamically unstable patients were excluded to avoid repeated punctures and increase in access time, our aim being to familiarize the trainee with a method that would make cannulating these very subsets of patients successfully in the operating room.

The demographic and haemodynamic parameters in our study was comparable between both the groups and was like the previous studies done on IJV cannulation techniques.[7,9,11] The access time was significantly lower in Group 2 as compared to Group 1 in our study (258.78 ± 218.17 sec vs 301.60 ± 201.03 sec, p = 0.030). It is along expected lines because direct sonographic visualization of the IJV can be expected to lessen access time as opposed to the finder needle and cannulation technique used in the Landmark technique.[6,7,9,12] However, the access time range reported in these studies is dramatically lesser in both the study groups (9.8 – 95 seconds in USG group and 45-236 seconds in landmark group as compared to our results. Aspiration of venous blood into syringe has been taken as access time in these studies and into the central venous catheter in ours, which explains the longer access time in our patients.

RIJV cannulation in the first attempt was more in Group 2 (76% vs. 74%, p = 0.051) although it was not statistically significant. Similar results have also been reported in the previous studies.[6,7,9,12] The maximum attempt required was third attempts (in 6 patients) in the landmark group, while all the patients in the USG group were successfully catheterized within the second attempt (in 5 patients). The mean no of attempts required for cannulation in our study (1.66 ± 1.29 vs 1.48 ± 1.05, p = 0.657) was comparable to similar studies by which reported a range of 0.42 ± 0.92 to 2.8±3.0 in the landmark group vs 1.08 ± 0.33 to 1.4 ± 0.7 in the USG group in landmark and USG group respectively.[6,7,10,12] Carotid artery puncture was seen in 9 patients (18%) in Group 1 and none in Group 2 (p=0.003). The reported complication rates in previous studies are 4.73 - 8.43% carotid punctures in landmark group and 0 - 1.39% in ultrasound group. [6,7,10,12] Anterior overlap of IJV over CA has been shown to predispose patients under CVC to inadvertent CA punctures.[14-16] It is for precisely the same reason that patients in the USG group did not have this complication because of direct visualization of the vessels during the procedure. None of the patients in our study had pneumothorax. Body mass index (BMI) does not appear to be a factor contributing to unsuccessful cannulation, prompting us to forgo these anthropometric measurements in the analysis of results.[17]

In pandemic ravaged hospitals safe, successful and quick IJV cannulation by young trainee anaesthesiologist is desirable and will be a valuable tool in providing basic critical care support, [5,18] not to mention the safety to the health care providers by reducing the duration of exposure for the procedure.

Limitation

Our study was done in a critical care setting, where conditions are slightly different from an operating room, and that we presumed the experience of the trainee would be replicated in the operating room. We have not included anthropometric measurement in the analysis of result, neither have we followed up the patients for any infective or thrombotic complications beyond the period of observation.

CONCLUSION

Trainees can learn the USG-guided cannulation of IJV quickly and perform it safely in patients. This is very relevant to the pandemic times and can help hospitals tide over the manpower crunch brought about by the pandemic.

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