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Original Research Article

COMPARISON OF SHORT AXIS AND OBLIQUE AXIS TECHNIQUES OF ULTRASOUND GUIDED INTERNAL JUGULAR VEIN CATHETERIZATIONS - A PROSPECTIVE RANDOMIZED STUDY OF 60 CASES.

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ABSTRACT

Context: Central venous catheterization (CVC) is integral part of management in modern era. Studies have compared different approaches of Ultrasound guided CVC with number of variables, but still inconclusive.

Aims: Comparing ultrasound guided CVC techniques, short vs oblique axis, for novice ultrasound operator in terms of successful cannulation (SC), venous access time (VAT), attempts, cannulation time (CT) and complications.

Methods and Material: Study includes 60 patients >18 years, requiring CVC, undergoing surgery under general anaesthesia. A single anaesthetist who is novice to both, short and oblique, approaches of ultrasound guided CVC, performed cannulation.

Statistical analysis used: SPSS17.0 version used. Student's T test and Mann Whitney U test used for continuous variables. Nominal categorical data compared using Chi-square and Fisher's exact test. $P<0.05$ considered statistically significant.

Results: Demography and clinical characteristics were comparable. SC in S group (93.33%) was found to be comparable to 'O' group (86.66 %). In 'S' and 'O' groups VAT was 46.78+/-17.91 and 54.65+/-15.87 respectively. In group S, like group O, only 2 cases required >3 attempts for IJV cannulation. CT in both groups (123.64+/-44.03 in S group and 124.63+/-40.8 in O group) was comparable.

Complication rate was higher in 'O' (13.3%) vs 'S' group (3.3%), but it was statically insignificant.

Conclusions: Short and long axis approaches of ultrasound guided IJV catheterization are comparable in terms of SC, attempts, VAT, CT and complications.

Key-words: Central venous catheterization, Ultrasound, Short axis, Oblique axis.

Design: Prospective, randomized, comparative study

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1. INTRODUCTION

Central venous catheterization (CVC) plays an important role in management of patients in the modern era. It can be said without exaggeration that the rapid administration of fluid, wide range of hemodynamic monitoring, total parenteral nutrition, hemodialysis etc. would not be possible without this procedure.

Literature describes wide range of anatomical landmark guided techniques for internal jugular vein (IJV) puncture. Procedure under landmark guidance comes with high failure rate and complications [1]. And thus, use of Ultrasonography guidance for central venous access has been introduced which converted a blind procedure into a "procedure under vision." Ultrasound (US) offers better identification of the target and collateral structures and real time guidance to precisely place needles and thus helps to minimize complication [2,3].

Different US imaging approaches such as short-axis (SAX) approach, long-axis (LAX) approach, and oblique axis (OAX) approach have been described previously. Each approach has its own merits and demerits. In the SAX ("out of plane") approach, US probe is placed perpendicular to the venous anatomy which permits simultaneous visualization of both artery and vein. It has been observed that the control on needle tip is difficult with SAX approach. In the LAX ("in plane") approach, a probe is placed parallel to venous anatomy which optimizes needle visualization, but it does not favor anatomical challenges such as short neck length. The OAX approach, a new method of localization that combines the advantages of the short- and long-axis planes, can allow us to visualize both the internal jugular vein and internal carotid artery, using a probe alignment that is midway between SAX and LAX approaches.

But understanding of all these approaches, hand eye coordination with US and simulating a two-dimensional view with three-dimensional real world is a major obstacle for a trainee.

Many studies have come up comparing different approaches of US guided CVC [4-7]. Studies also compared learning curve for these approaches. But still the debate is inconclusive. Therefore, we aimed at comparing standard SAX approach with a new 0AX approach of US guided CVC, for a novice US operator with respect to successful cannulation, venous access time, number of attempts of cannulation, time taken for successful cannulation and complications.

2. METHODS

After obtaining approval from the institutional ethical committee, we conducted a prospective, randomized control, comparative study.

60 patients of age more than 18, Patients more than 18 years of age undergoing surgery under general anesthesia between January 2021 and January 2023, in whom CVC was indicated, were included in the study.

Patients having history of ipsilateral IJV cannulation in past 72 hours, coagulopathy (INR values > 1.5 and platelet count <50,000) or with presence of IJV thrombosis, cutaneous erosions, subcutaneous hematoma, subcutaneous emphysema, signs of infection and previous

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surgical intervention at or close to puncture site were not included in our study. Thus, 60 patients formed the study cohort.

Written and informed consent was taken from the participants for the procedure. Random number table was used to randomly allocate the patients in two groups.

Group O – Oblique axis technique was used in this group.

Group S - Short axis technique was used in this group.

2D Ultrasound machine with 12 MHz linear probe and triple lumen Arrow central venous catheter were used for the procedure. Each cannulation was performed by single anesthetist who is new for both the above-mentioned techniques of ultrasound. An observer was present during the procedure for making observations. Subjects undergoing surgery under general anesthesia were placed in 30-degree head low position with head turned slightly on the opposite side. Right side IJV was always attempted first because of its straighter course. But, in cases of previous scars or thrombosis, left side was attempted first. Following observations were recorded:

Successful Cannulation - Cannulation was considered successful once a flexible guide-wire has been satisfactorily inserted into the internal jugular vein.

The procedure where we took >3 number of attempts or >180 seconds for cannulation, was considered as failed or unsuccessful cannulation.

Venous access time - Time between insertion of needle into the skin to aspiration of blood in syringe.

Cannulation attempt - puncture of skin to aspiration of blood without change of direction will be counted as an attempt. Withdrawal and change of direction will be counted as a new attempt.

Ultrasound probe was placed transversely i.e. perpendicular to IJV axis in group S at the junction of sternal and clavicular heads of sternocleidomastoid muscle and at the level of cricoid cartilage. With OAX, the operator first obtained a short-axis view of the vein and then rotated the transducer to a position midway between the SAX and LAX views, inserting the needle just underneath the footprint of the probe, following its long axis from lateral to medial. After the introduction of the needle (superior end of transducer probe in group O and mid-point of the longitudinal axis of the probe in group S), the needle tip and shaft were visualized. The time taken for free flow of venous blood entering the syringe was noted. Further movement of needle was stopped and guide-wire was introduced. Seldinger technique was used for catheter placement. Catheter was fixed using suture material and sterile dressings.

Correct catheter placement was confirmed by ultrasound guided visualization of the guidewire. In the recovery room, post procedural chest x-ray was advised to identify complications like pneumothorax and mal-positioning of catheter. All complications were treated accordingly.

Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0. The comparison of normally distributed continuous variables between the groups was performed using Student’s t test. Nominal categorical data between the groups was compared using Chi-squared test and Fisher’s exact test. Non-normal distribution

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continuous variables were compared using Mann Whitney U test. For all statistical tests, a P value less than 0.05 was considered statistically significant.

3. RESULTS

Patient characteristics and clinical data are summarized in table 1. Both groups are comparable in terms of demography and clinical characteristics.

	Group O	Group S	P value
Age	42.82 (SD 13.3)	40.32 (SD 12.62)	0.206
BMI	25.097 (SD 3.18)	26.856 (SD 4.38)	0.989
Heart Rate	82.87 (SD 8.12)	85.12 (SD 5.75)	0.255
SBP	145.57 (SD 13.12)	151.33 (SD 10.3)	0.115
DBP	86.12 (SD 8.65)	92.74 (SD 11.46)	0.085
SPO2	98.96 (SD 0.77)	99.43(SD 0.95)	0.758
Platelet count	2.65 (SD 0.72)	2.27 (SD 0.78)	0.017
INR	0.94 (SD 0.11)	1.03 (SD 0.14)	0.043

Table 1: Demography and Clinical Characteristics

In group S, 58.60% IJV cannulations were done in single attempt as compared to only 45.7% in group-O patients. In 25.03% patients of group S and 28.73% patients of group O, two attempts were made. Three attempts were needed in 9.7% of patients in group S members and 18.9% of patients in group O. In group S, like group O, only 2 cases required >3 attempts for IJV cannulation (Chart 1).

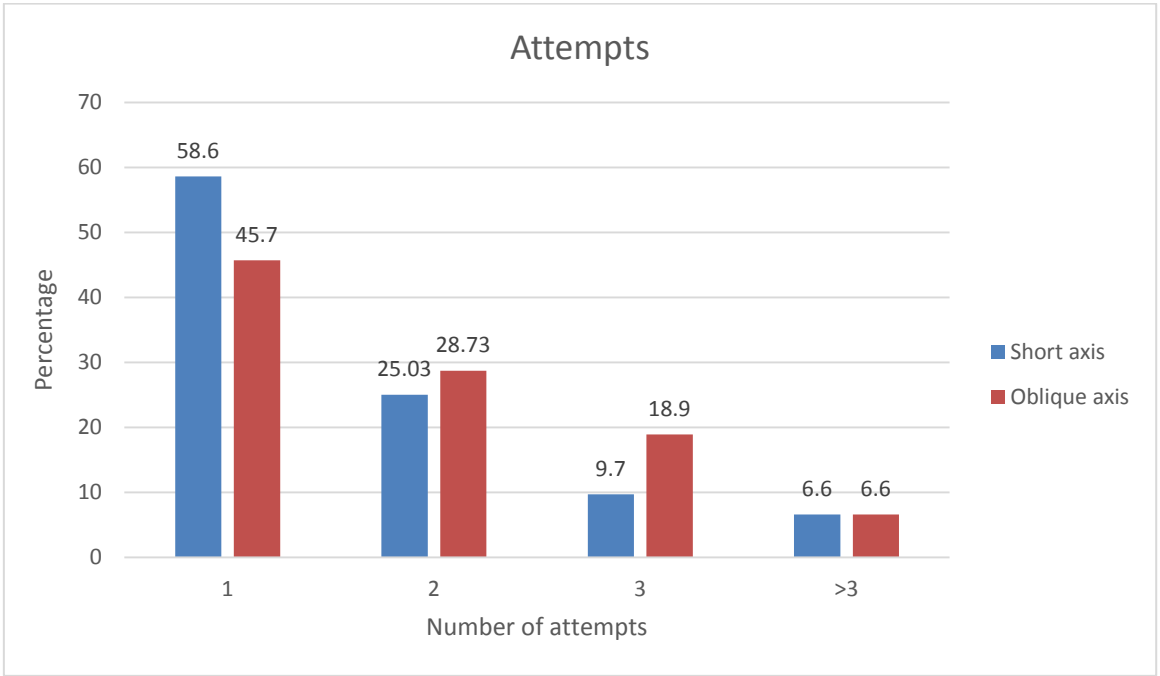

Chart 1: Number of Attempts

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In group S, the mean venous access time was 46.78 ± 17.91 sec whereas it was longer for the group O (54.65 ±15.87 sec) with no statistically significant difference (Table 2).
The time taken for cannulation in both groups was found to be almost same (124.63 ± 40.8 for group O and 123.64 ± 44.03 for group S with P value = 0.928) (Table 2).

	Group O	Group S	P Value
	Mean ± SD	Mean ± SD	
VAT	54.65 ± 15.87	46.78 ± 17.91	0.601
CT	124.63 ± 40.8	123.64 ± 44.03	0.899

Table 2: Venous access time and Cannulation time

The rate of successful cannulation in group O (86.66%) was almost equal to group S (93.33%) with P value of 0.549 (Chart 2).

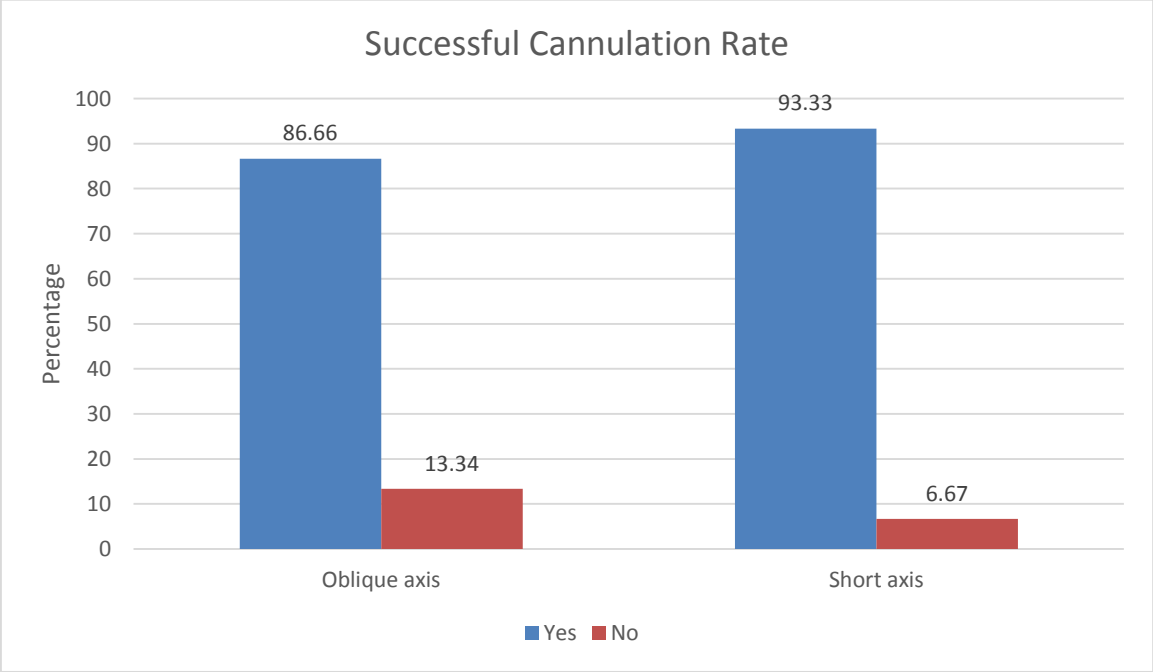

Chart 2: Successful Cannulation Rate

The incidence of complication in group S is 4.5% and 9.13% in O group with p value of 0.463, showing that this difference is statistically insignificant. We encountered two carotid artery puncture, two cases of hematoma formation and no mal-position seen in group S, whereas only single case of hematoma was found in group O (Table 3).

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Complications	O group	S group	P value
Carotid artery puncture	0	2	0.876
Hematoma	1	2	0.953
Malposition	0	0	-
Pneumothorax	0	0	-

Table 3: Complications

4. DISCUSSION

We had 54 cases of successful cannulations out of 60 (26/30 in O and 28/30 in S group). As operator required more than 3 numbers of attempts in 2 of his cases and more than 180 seconds in remaining two cases, we considered all these 4 cases as unsuccessful cannulation for group O. In S group, we required more than 3 attempts for IJV cannulation in 2 members and thus had 93.33% successful cannulations. We did not find statistically significant difference in successful cannulation rates between the two groups (P value 0.731). Although the first pass successful cannulation in S group was 58.60% which is more than group O which was 45.7% (P value = 0.11).

But there are studies by M. Batllori et al (220 cases) concluding that the first needle pass successful cannulation was lower with the S group with success rate ranging between 69.9 % as compared to success rate 73.6% in OAX group [7]. This could be because the study was being performed by experienced and proficient anesthetists while in our study the operator was inexperienced and new to the procedure.

In group S, 58.60% IJV cannulations were done in single attempt as compared to only 45.7% group O patients. In 25.03% patients of group S and 28.73% patients of group O, two attempts were made. Three attempts were needed in 9.7% of patients in group S members and 18.9% of patients in group O. In group S and group O, only 2 cases required >3 attempts for IJV cannulation.

Study done by Divya Sujatha Sivadasan et al revealed significantly lesser number of needle passes required in OAX (1.27+/-0.45) group and SAX group (1.57+/-0.57) than long axis approach. This study also observed that more attempts were needed in SAX approach which is in contrast to our study. In the short axis, on US, the vessel appears to be a dark circle, easy to localize and thus less alignment of US probe with vein is needed. However, In the OAX, length of the needle can potentially be tracked on the US screen as it enters the blood vessel along with carotid artery in field but this requires more hand-eye coordination and expertise than the SAX approach [8].

In our study, we observed faster venous access was achieved with SAX [46.78 ± 17.91] as compared to OAX [54.65 ± 15.87] but the difference was statistically insignificant (p value 0.601). The time taken for cannulation in both groups is almost same. It was 124.63 ± 40.811 in group O and 123.64 ± 44.03 in group S (P value = 0.899). In contrast to our study, mean venous access, guidewire insertion and catheterization time were found to be shorter in OAX than SAX approach in the study conducted by Jatin Lal et al [9]. Although the OAX approach to vessel cannulation affords unique advantage of better and continuous visualization of

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needle, but maintaining the position of US probe on the skin may be challenging, especially for novice ultrasound operators. So, the loss of imaging during the procedure and re-localization of venous field could be considered as the reason behind prolong procedural time with OAX approach.

According to the study in which interventions were done by experienced operator, the VAT in both groups was quite comparable. According to them, visualization of the IJV on the short axis was particularly useful for catheterization of the small vessels, whereas the primary advantage of the longitudinal view is to visualize the advancing needle tip.

In our study we encountered complications like carotid artery puncture and hematoma. None of our patients had malposition, pneumothorax and nerve injuries.

Carotid artery puncture was seen in two cases using SAX approach while no such complication occurred with OAX approach. But the difference was not statistically significant in our study. Both the vessels are seen on the single screen in SAX, and OAX approach but longer course of vessels can be seen with OAX approach.

We have seen the incidence of hematoma in both the groups. In S group two cases of hematoma, both due to carotid artery puncture, whereas there was only one case of hematoma seen in O group. In O group, the one case where we found hematoma, had trauma to the posterior wall of IJV. Thus, hematoma can be seen with either venous or arterial injury. Possible explanations were given by studies, discussed below, regarding venous injuries with US guided cannulation. In the study done by M. Batllori et al, OAX was found to be more effective than SAX in avoiding PVWP, which could make it preferable to SAX [7].

5. CONCLUSION

Short and Oblique axis approaches of ultrasound guided internal jugular vein catheterization are found to be comparable in terms of success rate, number of attempts, venous access time, cannulation time and complications for a novice operator. Both the techniques have similar learning curve. However, a multicentric trial, large sample size and numerical parameter for explaining learning curve could have strengthened the study.

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