

Research Article

A study on complications in ultrasound guided catheterization of the internal jugular vein

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ABSTRACT

Background: With the advanced knowledge in medical monitoring, ever increasing value has been placed on the establishment of central venous catheter. During the past few years, monitoring of central venous pressure has become an important aid in the management of critically ill patients. Doppler ultrasound was first used to assist central venous catheter insertion in 1984. Ultrasound has been applied to describe the anatomy of the IJV and to evaluate various techniques for percutaneous cannulation. Real time sonography improves access to the vein compared with the traditional method. Ultrasound guided cannulation limits complications and also the decreases the cannulation time. For reducing the complication in traditional method we have conducted the study through ultrasound guide and observed the complications in new method.

Methods: Thirty critical care patients were selected for IJV cannulation either by ultrasound guided technique. This study conducted in department of anesthesiology and critical care, M. S. Ramaiah medical college, Bangalore.

Results: In our study there was 100% success rate for first attempt cannulation in USG technique. The mean access time in USG technique was 152.50 ± 63.90 sec. in USG technique arrhythmias were noted in 1 (3.3%) case during the study. No cases of haematoma, pneumothorax, haemothorax, nerve Injury, carotid artery puncture and catheter malposition were noted during the study in USG technique.

Conclusion: Ultrasound guided technique improves the cannulation of the IJV with respect to safety, rapidity and comfort to the patient during the procedure.

Keywords: Internal jugular vein, Ultrasound, Catheter, Critical care

INTRODUCTION

Cannulation of the IJV was first described in 1969. Various positions were used to access cannulation but they were frequently associated with complications such as arterial puncture, pneumothorax, neurological damage, infection, dysrhythmias, atrial thrombus, cardiac rupture.^{1,2} Doppler ultrasound was first used to assist central venous catheter insertion in 1984. Ultrasound has been applied to describe the anatomy of the IJV and to evaluate various techniques for percutaneous cannulation.

Real time sonography improves access to the vein compared with the traditional method. Ultrasound guided cannulation limits complications and also the decreases the cannulation time. However this facility may not be available in many centers because of its high cost. It also needs an experienced operator which is an additional limiting factor for its use. Real time ultrasonography can be used to view the in vivo vascular anatomy of the neck and in asserting the size of IJV and its anatomical relations. These features make this instrument a useful tool to study various body positions and in finding out the

position which maximize IJV diameter, thereby increasing the first pass success rate. Studies in the Indian context are lacking and hence the present study is to assess whether IJV cannulation using an ultrasound assisted method leads improvement of the procedure.

With advanced knowledge in medical monitoring ever increasing value has been placed on the establishment of a central venous catheter.³ During the past few years, the monitoring of central venous pressure has become an important aid in the management of seriously ill patients. It is indispensable in the treatment of shock, regardless of the cause and is used to great advantage during surgery when the replacement of moderate or large amount of blood or fluid is anticipated. Central venous cannulation also provides a long term continuous intravenous route and a source for withdrawal of multiple blood samples, obviating the necessity and discomfort of multiple vein puncture. It has made the use of venous cut down virtually obsolete. In addition, patients at risk for venous air emboli may have central venous catheters placed for aspiration of entrained air. Central venous access is also required to initiate transvenous cardiac pacing, temporary haemodialysis or pulmonary artery catheterisation for more comprehensive cardiac monitoring. Among the numerous potential sites for central venous cannulation the most popular is internal jugular vein, because it is technically easier, external anatomical landmarks are definite, superficial and more accessible. Since its introduction into clinical practice in late 1960's, percutaneous venipuncture or cannulation of right internal jugular vein has been the preferred method for CVC.⁴ The right internal jugular vein essentially forms a straight line to right atrium and shorter route. Also the dome of the pleura is higher on the left side and the thoracic duct is located on the left.⁵

F. M. Messahel et al.⁶ in their study showed that the conscious patients were able to move their neck freely while the catheter was in place. This could be because of lack of pain at the site of insertion as there was no intramuscular penetration by introducing the needle. James Brinkman et al.⁷ showed that often the requirement for CVC occurs unexpectedly during procedure in the operating room which could be performed at the head of the patient during surgery. Various other sites of cannulation, basilic and external jugular veins may fail because of technical difficulties and thrombosis, while the subclavian route raises the valid objection of dangerous, even fatal, pneumothorax.⁸ Bart G. Denys et al.⁹ has been used Ultrasound to assess the normal IJV anatomy, to refine the technique of percutaneous cannulation of IJV. Machi J et al.¹⁰ was of the opinion that ultrasound has been evaluated as an adjunct to central venous access under routine circumstances of CVC.

Hatfield et al.¹¹ showed that ultrasound guidance reduces the time required for the procedure, to locate the vessel or give real time guidance, reduces the number of needle

passes needed to puncture the vein, increases the overall success rate of venous puncture and minimizes complications such as arterial puncture or pneumothorax. Two-dimensional ultrasound images provide useful information about presence and patency of jugular vein, distensibility and compressibility, position of jugular vein with respect to the carotid artery in the neck. The distensibility of the jugular vein increases with the valsalva maneuver and Trendelenburg position which can be appreciated on ultrasound. It also provides useful information as the needle tip is advanced through overlying tissues and vein. It images the vein longitudinally enabling the operator to monitor the passage of needle through the anterior wall of the vein. Ultrasound localization of internal jugular vein is by their position, lack of pulsatility, compressibility with minimal pressure and increase in vein lumen size induced by the valsalva maneuvers which were demonstrated by Farell J et al.¹² The use of surface ultrasound technique to locate the position of IJV will greatly facilitate the placement of CVC as suggested by Legler D. Nugent et al.¹³

The National Institute for Clinical Excellence¹⁴ (NHS 2002) guidelines issued in September 2002 recommend the use of ultrasound imaging for catheter insertion into the internal jugular vein in adults and children in elective situations, and that it should be considered in most circumstances when central venous catheterization is necessary in both elective and emergency situations. These recommendations are supported by a recent meta-analysis.¹⁵ which suggested a significantly reduced failure rate for cannulating the internal jugular vein but limited evidence supporting ultrasound use for subclavian and femoral Vein catheterization. The present study focused on complications occurs in ultrasound guided catheterization of the internal jugular vein.

METHODS

Thirty critical care patients were selected for IJV cannulation either by ultrasound guided technique. This study conducted in department of anesthesiology and critical care, M. S. Ramaiah medical college, Bangalore.

Ultrasound-guided technique

Aloka SSD 900 2-D ultrasound unit with 3.5 MHz transducer was used. The transducer contact surface was covered with 5% povidone-iodine solution and a sterile transparent occlusive material, tegaderm. Sterile 5% povidone-iodine solution was used as the ultrasound conductive medium between the transducer and the patient's skin.

Ultrasound scanning was done by sonologist. Transducer was placed at 45 degrees to the neck on side required with the sonologist standing next to the patient on the same side. The transducer was placed parallel and superior to the clavicle, over the groove between the sternal and clavicular heads of the sternocleidomastoid

muscle. Both internal jugular vein and carotid artery were visualized. The finder needle attached to 5 cc syringe containing heparinised saline was advanced through the skin, internal jugular vein was located, and the needle was visible on the screen. The finder needle was used as a guide to advance 5 cc syringes with 18 G needle.

The Seldinger technique with J-tip guide wire was employed for central venous cannulation.

The following observations were made.

- Method of cannulation: Land Mark Guided technique (LMG) or ultrasound guided technique (USG).
- Site of cannulation.
- The access time in seconds-the time taken from skin puncture to the suturing of the catheter.
- Number of attempts taken to cannulate IJV.
- Any complications like carotid artery puncture, arrhythmias, skin hematoma, haemo/pneumothorax, nerve injury and catheter misplacement.
- Whether any difficulty encountered during the procedure, difficulty to thread guide wire or catheter.
- All the cases were subjected to chest X-ray postero-anterior view for confirmation of catheter position.

RESULTS

Site of cannulation

The distribution of sites of cannulation in USG technique as follows 17 (56.7%) patients underwent IJV cannulation on the right side while 13 (43.3%) patients underwent on the left side.

Table 1: Distribution of site of IJV cannulation among study population.

Site	Method
	USG
LT IJV	13
	43.3%
RT IJV	17
	56.7%
Total	30
	100.0%

Access time

Access time (time take in seconds from initial skin puncture to skin suturing) to successfully cannulate the

IJV has been described in Table 2. The access time in USG technique it was 152.50 ± 63.907 seconds of the mean ± standard deviation in this study.

Table 2: Distribution of mean access time in seconds among study population.

Access time	N	Mean access time (secs)	Std. deviation	Minimum	Maximum
USG	30	152.50	63.907	60	315

Cannulation attempts

The distribution of attempts to successfully cannulation IJV has been dealt under Table 3. In this study, in USG technique, all cases 30 (100%) were cannulated in the first attempt itself (Table 3).

Table 3: Distribution of cannulation attempts among study population.

Number of attempt	USG
	30
1	100.0%
30	
Total	100.0%

Complications

In USG technique there were no cases of carotid artery puncture. In USG technique arrhythmias were noted in 1 (3.3%) case during the study. No cases of haematoma, pneumothorax, haemothorax, nerve injury and catheter malposition were noted during the study in USG technique.

Table 4: Distribution of complications among study population.

Complications	USG
Artery puncture	0 0.0%
Arrhythmias	1 3.3%
Haematoma	0
Pneumothorax	0
Haemothorax	0
Nerve injury	0
Catheter	0

Technical problems

In this study, the technical problems such as difficulty in threading guide wire after successful cannulation of IJV and the difficulty in successfully cannulating In USG

technique, difficulty in threading guide wire after successful IJV cannulation was encountered in 1 (3.3%) cases (Table 5).

Table 5: Distribution of technical problems among study population.

Technical problems	USG
Guide wire problems	1 3.3%
Cannulation problems	1 3.3%
Classic head low position	0 0.0%

DISCUSSION

As suggested by Thomas Surez et al.¹⁶ the knowledge of anatomy of neck is vital and the relationship of the IJV to the sternocleidomastoid muscle and CA is the key for understanding the position of the vein in the neck. In practice, surface markings are always not reliable means of locating the Internal Jugular Vein as its position, particularly in a lateral plane tends to vary considerably. The position of the patient throughout the study was supine with 15 degree trendelenburg position. One patient in USG technique had difficulty in lying supine with 15% trendelenburg position as the breathlessness worsened. The patient was reassured and the procedure was carried out in supine position without trendelenburg tilt. A pillow was also put under the shoulder blade. The neck was rotated to opposite side in the range of 20 to 30 degree. Our study did not make any comparison of various degrees of rotation of the head and the size of IJV. Sulek et al.¹⁷ has studied that more than 40 degree of head rotation to the left had changed the relationship of IJV with CA from lateral to anterior. This resulted in more number of carotid artery puncture complications. The valsalva maneuver increases the diameter of IJV by about 126 % as studied by M. Leon Skolnick et al.¹⁸ was not used in our study for the facilitation of IJV cannulation in conscious patients.

In this study the triangle of sternocleidomastoid muscle comprising of sternal and clavicular heads of the sternocleidomastoid and the medial third of the clavicle in the neck, also the carotid artery pulsations were felt. In landmark-guided technique, these anatomical landmarks were taken into considerations while cannulating IJV. The carotid artery was palpated in the landmark-guided technique in the sternocleidomastoid triangle and both the finder and seeker needles were inserted lateral to CA to find the IJV. In this study throughout 3.5 MHz, 2 D, portable ultrasound was used and was performed by a sonologist. The probe was aseptically prepared with 5% povidone-iodine solution and sterile transparent adhesive dressing, tegaderm and 5% povidone-iodine solution was used as a conducting or coupling agent. The probe resolution was sufficient to visualize CA and IJV. The

CA was visualized as a thick-walled, non-compressible by probe, with no change with the respiration whereas IJV was visualized as thin-walled, compressible by the probe, and decrease in diameter on inspiration. The disadvantage of 3.5 MHz, 2-D, portable ultrasound was the poor differentiation of CA and IJV by dynamic changes with each cardiac activity as with Doppler ultrasound. The limitations of 2-D was that, though the needle was visualized in the vessel, no aspiration of blood was possible because the needle was parallel to the wall of the vessel restricting the third dimension of the image. These limitations can be overcome by the 3-dimensional colour Doppler dedicated machine. However the cost limits its use in the day to day practice in most of the hospitals. The real time images of 2D portable ultrasound are superior to still images for the CVC of IJV. The limitations of free-hand access of IJV can be overcome by Rite-site machine. In the Rite-site machine, small transducer with introducing needle are attached together connected to a real time 2-D ultrasound but the cost is a limiting factor. The mean age in USG technique it was 49.93 ± 18.42 years (ranging from 17 to 90 years). In USG technique, 17 (56.67%) patients underwent IJV cannulation on the right side while 13 (43.33%) patients underwent on the left side. The access time (time from the penetration of the skin to suturing the catheter) included the skin passes with finder and seeker needle together. The access time corresponded with an increase in number of attempts. The access time was shorter in USG technique with a mean of 152.50 ± 63.907 seconds this results in agreement with study of Tista A et al.¹⁹ with 60.9 ± 55 seconds for USG technique. With USG technique more veins were entered on the first attempt. In our study, in USG technique all the 30 (100%) patients were cannulated on first attempt these results are in agreement with studies of Dimitrios Karakisos et al.,²⁰ Piero Antonio et al.,²⁰ Wg Cdr R MSharma et al.,²¹ Tista A et al.,¹⁹ Bart G. Deny et al.²² The complication rates were 3 (10%) in USG. The carotid artery not punctured in no cases in Ultrasound guided technique this result in agreement with Dimitrios Karakisos et al.²³ Piero Antonio et al.,²⁰ Troianos et al.²⁴ respectively. There were no serious complications like pneumothorax or nerve injuries, the same found in following studies Dimitrios Karakisos et al.²³ study and Tista A et al.¹⁹ study. The other complications related to cannulation rather than technique were ventricular ectopics on ECG-monitor while passing the guide wire was noted in one patient of USG technique group which reverted back to sinus rhythm on adjusting the depth of insertion of the guide wire. In this study all the chest radiographs in both the groups were found to be normal.

CONCLUSION

The results of present study are help in giving anesthesia with help of ultrasound guided technique. The ultrasound guided technique is very much cost effective than traditional land mark technique.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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