Ultrasound Guided Catheterization of Internal Jugular Vein Technique Versus Standard Landmark Technique

Shizan Hamid Feroz*, Syed Hamid Ali Shah*, Faisal Wahid**
* Department of Anesthesiology, Pain and Intensive Care, Armed Forces Institute of Urology, Rawalpindi; ** Department of Anaesthesiology, Pain and Intensive Care, CMH, Loralai.

Abstract

Background: To compare, average access time, number of attempts and the complications resulting from cannulation of internal jugular vein by standard landmark technique with real-time ultrasound guided technique.

Methods: In this comparative study, patients (n=200) undergoing different types of major surgical procedures, were divided in two groups. Anaesthetists and other staff were blinded to the randomization schedule and block size. After successfully securing the endotracheal tube, patients were placed in supine position with 15 degree head down. CV lines were first attempted on right side of neck and patients face was turned to left. On real time ultrasound unit carotid artery was selected and linear-array ultrasound probe was attached to it and gel was applied to it and wrapped in a sterile plastic sheath. Transducer was placed parallel and superior to right clavicle over the groove between sternal and clavicular heads of sternocleidomastoid. This readily visualized internal and external jugular vein and carotid artery. Real time two dimensional view was used to identify Internal jugular vein and after checking its compressibility, an 18G, 10cm needle was advanced through skin under ultrasound guidance. After successful aspiration of blood a guide wire was placed through needle and needle was removed and after dilating the tract with dilator a CV line was placed over guide wire. In landmark technique patients were prepared in the similar manner as for ultrasound guided technique. A 10cm 18-gauge needle attached with 10 ml syringe was introduced in the direction of respective nipple (right or left side) at the apex of triangle made by sternal and clavicular heads of sternocleidomastoid muscle. Return of venous blood in to syringe on aspiration was taken as confirmation of entry in to vein but color of blood and pressure of flow back was used as indicator whether needle has accidentally punctured the carotid artery or not.

Results: Both the groups were similar with respect to age, gender, weight, site of cannulation, and for presence of risk factors for difficult cannulation. Hematoma was observed in only one patient in ultrasound group as compared to nine patients in landmark group. Haemothorax and pneumothorax were not observed in any patient in ultrasound group. In landmark group 2% had haemothorax and 3% had pneumothorax. Carotid puncture was noted in 7% in landmark group, while in ultrasound group carotid puncture was not observed (p less than 0.050). Average access time was significantly lower in ultrasound group than in landmark group. Procedure success rate was 100% in ultrasound group and 95% in landmark group.

Conclusion: Ultrasound guided technique, as compared with landmark technique, is effective in reducing the complications associated with central venous cannulation.

Key Words: Ultrasound guided catheterization, Internal jugular vein technique, Standard landmark technique

Introduction

Cannulation of internal jugular vein (IJV) is commonly performed in operation theatres for hemodynamic monitoring intraoperatively and for administration of antibiotics, fluids, and parenteral nutrition and hemodialysis in postoperative period. Landmark techniques have been described since long.1,4 In these techniques different landmarks are used to select the site for safe puncture of skin and advancing the needle till IJV is punctured. As these are blind techniques such advancing needle may damage surrounding structures resulting in many complications which may be fatal at times. Due to anatomical variations and different individuals sometimes technique may fail to puncture the IJV. These complications and failures may be influenced by many patient factors including body mass index (BMI) and site of access. Operator experience and skill may
also influence the success rate and complication. Inability to cannulate IJV can occur in a high percentage of cases, up to 19.4% in certain studies.

With the advancement in ultrasound techniques, hardware and software refinement it was felt that direct visualization of IJV and carotid artery and surrounding structures and cannulation of IJV by direct real time ultrasound guidance can improve the success rate and reduce the complications. By using ultrasound cases can be identified where central venous access would be difficult or complications can emerge. Use of real time ultrasound guided central venous cannulation in operation theatres and ICUs have been very limited due to unavailability of specialized equipment at these places and lack of trained staff who can make use of the technique. Due to these facts there have been limited numbers of studies in the past which compare the results of the two techniques. Furthermore previous studies which used ultrasound to locate the IJV and then proceed with standard landmark technique have failed to show the advantage of using ultrasound for this purpose. It discouraged the use of ultrasound for this purpose. Studies still exist which have shown superiority of ultrasound guided technique over standard landmark technique.

**Patients and Methods**

This comparative study was conducted at operation theatre of Armed Forces Institute of Urology Rawalpindi from Sep 2013 to Aug 2014. Two hundred patients undergoing different types of major surgical procedures including renal transplant surgeries, radical nephrectomies, radical cystectomies and radical prostatectomies, were divided in two groups. They were named landmark group and ultrasound group respectively. Anesthetists and other staff, were blinded to the randomization schedule and block size. Access time and number of attempts were noted. Successful placement of central venous catheter (CVC) and some mechanical complications like pneumothorax and hemothorax were assessed by post op chest X-ray in ICU.

In real time ultrasound guided method CV line was placed in all patients when they were first anesthetized. After successfully securing the endotracheal tube (ETT) patients were placed in supine position with 15 degree head down and a soft small pillow was placed in between two shoulders. All the CV lines were first attempted on right side of neck and patients face was turned to left. After successful sterilization, neck area was draped. On real time ultrasound unit carotid artery was selected and linear-array ultrasound probe was attached to it and gel was applied to it and wrapped in a sterile plastic sheath. Transducer was placed parallel and superior to right clavicle over the groove between sternum 1 and clavicular heads of sternocleidomastoid. This readily visualized IJV, external jugular vein (EJV) and carotid artery. Now real time two dimensional view was used to identify Internal jugular vein (IJV) and after checking its compressibility, an 18G, 10cm needle was advanced through skin under ultrasound guidance to IJV. After successful aspiration of blood a guide wire was placed through needle and needle was removed and after dilating the tract with dilator a CV line was placed over guide wire and latter on it was fixed.

In landmark technique patients were prepared in the similar manner as for ultrasound guided technique. A 10 cm 18-gauge needle attached with 10 ml syringe was introduced in the direction of respective nipple (right or left side) at the apex of triangle made by sternal and clavicular heads of sternocleidomastoid muscle. Return of venous blood into syringe on aspiration was taken as confirmation of entry in to vein but color of blood and pressure of flow back was used as indicator whether needle has accidentally punctured the carotid artery or not. Rest of the steps of placement of CV line was similar as described for ultrasound guided technique. All CV lines were placed by well trained consultant anesthetists with more than 20 years of experience in the field. This was done to minimize the effect of operator experience on success rate and technique related complications.

The outcomes which were assessed included, access time (time between penetration of skin and aspiration and free flow of venous blood), the average number of attempts before successful attempt (defined as separate skin punctures), success of placement, the rate of mechanical complications. Preparation time for both techniques was similar. Access time was measured by stop watch and recorded in seconds. Student t test was used for independent means, and fisher exact test or X thinks were used to identify differences between two groups. A p value less than 0.05 was considered significant.

**Results**

There were no significant differences between two groups with respect age, BMI, gender, presence of risk factors for cannulation, previous mechanical complications, previous difficulties during cannulation, known vascular abnormalities, untreated coagulopathy, and skeletal abnormalities (Table 1). Only 5 patients in the landmark group in whom
catheterization was unsuccessful were converted to the ultrasound method and in 3 of these patients anatomical variation of IJV was noted. Both transverse

**Table 1: Landmark group versus ultrasound group -Characteristics of study population**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Ultrasound group (n=100)</th>
<th>Landmark group (n=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (Female/male ratio)</td>
<td>0.42</td>
<td>0.38</td>
</tr>
<tr>
<td>Age (years)</td>
<td>61±11.4</td>
<td>60.4±10.8</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.3±5.1</td>
<td>24.76±5.8</td>
</tr>
<tr>
<td>Side of Catheterization (left/right)</td>
<td>12/88</td>
<td>9/92</td>
</tr>
<tr>
<td>Previous difficulties during catheterization</td>
<td>8(8.0%)</td>
<td>10(10.0%)</td>
</tr>
<tr>
<td>Previous mechanical complications</td>
<td>6(6.0%)</td>
<td>4(4.0%)</td>
</tr>
<tr>
<td>Untreated Coagulopathy</td>
<td>3(3.0%)</td>
<td>5(5.0%)</td>
</tr>
<tr>
<td>Skeletal deformity</td>
<td>7(7.0%)</td>
<td>8(8.0%)</td>
</tr>
<tr>
<td>Prior catheterization</td>
<td>9(9.0%)</td>
<td>6(6.0%)</td>
</tr>
</tbody>
</table>

* values are presented as means +_ SD

and longitudinal 2D images were used in Ultrasound method and their use in specific situation was left to the discretion of operator. By using these 2D images double puncture of IJV was avoided in all patients in ultrasound group. A post operative chest X ray was ordered for all patients immediately after shifting to post operative intensive care unit to detect pneumothorax and haemothorax and see the position of CV catheter. Mechanical complications rate was significantly lower in ultrasound group as compared to landmark group (Table 2). Hematoma was observed in only one patient in ultrasound group (1%) as compared to nine patients(9%) in landmark group(p less than 0.05).Haemothorax and pneumothorax rates were (0%) and (0%) respectively in ultrasound group and(2%) and (3%) respectively in landmark group. Carotid puncture was noted in 7% in landmark group,in ultrasound group no carotid puncture occurred(0%)(p less than 0.050).Average access time was significantly lower in ultrasound group(24±18.5 seconds) than in landmark group (36+_22.2 seconds).Procedure success rate was 100% in ultrasound group and 95% in landmark group.

**Discussion**

More than five million central venous catheterization(CVCs) are performed in United States each year. Over all complication rate is around 15%. Hematoma arterial puncture and pneumothorax are most common mechanical complications of CVCs. Operator training and experience may be an important factor in determining complications rate. Clinicians who have placed more than 50 CVCs have less than half the complications rate as compared to those who have placed less than 50 CVCs. There are many other factors which can influence complications rate resulting from central venous catheterization(CVCs). These factors include patient anatomy(for example local scarring from surgery or radiation, morbid obesity, cachexia, patient settings (for example patient receiving mechanical ventilation),co morbids and most of all technique of insertion of CV catheter. By real-time ultrasound guidance the desired vein and the surrounding anatomic structures can be visualized prior to and during the insertion of the catheter. By this method success rate can be improved and complications associated with CVC placement can be reduced. Present data further support the superiority of real-time ultrasound-guided IJV cannulation technique over landmark technique.

In present study overall success rate using landmark technique was 95%. Success rates using landmark technique in different studies have been reported between 85% to 99%. Our success rate falls within this range. Average number of attempts using ultrasound guided technique were 1.6±0.4 as compared to 1.9±2.5 using landmark technique. Incidence of pneumothorax 3% in present study using landmark technique falls in lower range of previous reported studies and hematoma formation in our study using landmark technique was 9% which is similar to previous studies. Mechanical complications rate in ultrasound guided group was almost nonexistent in our study which is quite the same as in previous studies. Hematoma was observed in only one patient in this group. Hematoma and pneumothorax was not observed in

**Table 2: Landmark group versus ultrasound group -outcome**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Ultrasound group (n=100)</th>
<th>Landmark group (n=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematoma</td>
<td>1(1%)</td>
<td>9(9%)</td>
</tr>
<tr>
<td>Hemothorax</td>
<td>0(0%)</td>
<td>2(2%)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>0(0%)</td>
<td>3(3%)</td>
</tr>
<tr>
<td>Access time (seconds)</td>
<td>24.1±18.5</td>
<td>36±22.2</td>
</tr>
<tr>
<td>Carotid puncture</td>
<td>0(0%)</td>
<td>7(7%)</td>
</tr>
<tr>
<td>Average number of attempts</td>
<td>1.6±0.4</td>
<td>1.9±2.5</td>
</tr>
<tr>
<td>Success rate</td>
<td>100(100%)</td>
<td>95(95%)</td>
</tr>
</tbody>
</table>
this group. Overall success rate in this group was 100%.

In present study all other factors which could influence the procedure success rate or incidence of complications were quite comparable having no significant difference. In previous studies most success rate using ultrasound technique have been documented in those studies in which operators were inexperienced.23,26 There are concerns of increased risk of catheter related blood stream infections due to use of extra ultrasound equipment and manipulation.26,27

**Conclusion**

Real time ultrasound guided technique of internal jugular vein catheterization offers advantages over standard landmark technique in reducing number of attempts, average access time, mechanical complications like hematoma, pneumothorax and haemothorax.

**References**