Comparison of the rate of success and incidence of complications associated with percutaneous cervical central venous cannulation of internal and external jugular vein.

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ABSTRACT:

Introduction: The central venous pressure monitoring is indispensable when the replacement of moderate or large amounts of blood or fluid is anticipated. The present study was designed to evaluate an easy, dependable and safe method of percutaneous cervical central venous catheter placement in the “central veins” via the external or internal jugular vein, employing a flexible angiographic J-tip guide wire. Material & Methods: After the institutional ethical committee approval, we studied 100 patients meeting inclusion criteria of either sex requiring central venous pressure monitoring during the hospital stay. Written consent was taken from all the patients after explaining the procedure in the language they understand. Results: Internal jugular vein cannulation was accomplished successfully in 94% of patients and External jugular vein catheterization yielded 80% success rate. Internal jugular vein is the vein of choice for central venous access as it is subject to almost no anomalies or positional variations. Conversely, external jugular vein catheterization appears to be safer without any serious sequelae but is less predictable for successful cannulation because of its tortuous course, presence of venous valves or due to presence of venous plexus just above the clavicle.

Keywords: central venous pressure, internal jugular vein, external jugular vein, cannulation, sequelae

INTRODUCTION:

During the last decade, central venous pressure (CVP) measurement has become an important part of management in critical care medicine and in operation theatre for high risk patients. The procedure requires that an intravenous catheter line be placed so that its tip lies in an intrathoracic “central vein”, usually the innominate vein or the superior vena cava. These central veins can be reached percutaneously from several different sites, i.e. the antecubital vein, subclavian vein, femoral vein or the cervical veins. Each approach has its merits and disadvantages. In 1930, Lewis used the external jugular vein as a manometer to record pressure changes in the right atrium, thus laying the foundation for the central venous pressure determination. He stated that in normal persons the zero pressure level of the fluid in the venous system is near the angle of Louis and this would apply to any position of the body. In the year 1981, Werner Frossmann, a urologist described central venous catheterization, for which he was awarded the Nobel prize in 1956. Among anesthesiologists especially, popular sites for this procedure is the internal jugular vein and
external jugular vein. The reason for this preference for internal jugular vein and external jugular vein is related to its consistent, predictable anatomic location within palpable landmarks.\textsuperscript{[2]}

Internal jugular vein has a short, straight valveless course and external jugular vein has a smaller, more tortuous and superficial course to the superior vena cava and the right atrium and its position at the patient’s head providing easy access.\textsuperscript{[2]}

Central venous pressure is the blood pressure at the junction of the vena cava and the right atrium. It reflects the adequacy of cardiac filling and cardiac performance. In most of the instances the value of central venous pressure will approximate to the mean right atrial pressure. The normal mean central venous pressure value is 8-10 centimeters of H\textsubscript{2}O with the manometer placed and zeroed at the right atrial level.

The central venous pressure monitoring is indispensable when the replacement of moderate or large amounts of blood or fluid is anticipated. A central venous catheter also provides a route for long term continuous intravenous infusion and a source for withdrawal of multiple blood samples, obviating the necessity and discomfort of multiple vein punctures and it has made the use of venous cut downs virtually obsolete.

Though the central venous cannulation has been widely used, it also carries a greater risk of complication. The commonest early complications are related to local trauma and include pneumothorax, haemothorax, subclavian haematoma, subcutaneous emphysema, arterial damage, pleural effusion, brachial plexus injury, air embolism and cardiac perforation.\textsuperscript{[3]}

However widespread use of the central venous catheter to monitor the right sided cardiac preload pressures has improved the care of many critically ill and high risk patients. The present study was designed to evaluate an easy, dependable and safe method of percutaneous cervical central venous catheter placement in the “central veins” via the external or internal jugular vein, employing a flexible angiographic J-tip guide wire.\textsuperscript{[4]}

**MATERIAL & METHODS:**

After the institutional ethical committee approval, we studied 100 patients of either sex requiring central venous pressure monitoring during the hospital stay. Written consent was taken from all the patients after explaining the procedure in the language they understand.

**INCLUSION CRITERIA**

1. In major surgical procedures like cardiovascular or massive abdominal or thoracic surgery for central venous pressure monitoring and fluid administration.
2. All critically ill patients admitted to our critical care units requiring central venous pressure monitoring for infusion of intravenous fluids and for parenteral nutrition.
3. Acute or chronic renal failure patients for dialysis.
4. Patients in whom it was very difficult to obtain peripheral venous access.

Exclusion criteria:

a. Patients with altered coagulation profile.
b. Burns involving neck region.
c. Patients with vertebral basilar insufficiency.
d. Multiple attempts i.e. > 3 attempts.
e. Infection at the puncture site.

**TECHNIQUE:**

For Internal Jugular vein- The technique employed was similar to that of Seldinger’s method.

The procedure was performed with strict aseptic precaution, under either local or general anaesthesia with the patients in a supine 30\degree trendelenburg position and the head turned to the contralateral side of the anticipated venipuncture.
Right side was usually preferred, the reason for this preference relate to its consistent, predictable anatomic location, and its short, straight valveless course to the superior vena cava and right atrium. For internal jugular vein, a typical "central mid line" approach was preferred by using the apex of the triangle formed by the two heads of the sternocleidomastoid and the clavicle as the insertion site, with the needle directed towards the ipsilateral nipple.

The chosen insertion site was prepared by scrubbing with multiple layers of povidone iodine and draping with sterile bibling towel. Following which a 16 gauge, 45mm, over needle intravenous cannula attached to a sterile 10ml syringe with heparinised saline (about 3-4 ml) to avoid clotting or air embolism and to facilitate easy handling of the catheter unit was directed caudally, laterally towards the ipsilateral nipple by maintaining continuous negative pressure within the syringe. When the vein was entered, as often indicated by free return of venous blood into the syringe, intravenous cannula was passed centrally into the vein over the needle and needle with the syringe were removed.

A successful cannulation of the vein was confirmed by aspiration of venous blood into the syringe. Then a 45cm long, 0.089cm diameter flexible angiographic J tipped guide wire was smoothly advanced through the intravenous cannula by closely observing the electrocardiogram to recognize arrhythmias. Then the intravenous cannula is withdrawn and a 16 gauge, 20 centimeter longer central venous cannula (Abbocath/Arrow) was advanced over the J tipped guide wire into the vein and subsequently the guide wire was gently extracted.

After removal of J wire, the central venous cannula was connected to the manometer and the catheter is then secured with a suture to the skin.

External jugular vein: For external jugular vein cannulation, patients were placed in a similar position (i.e 30° Trendelenburg position) and under similar strict aseptic precaution, either right or left external jugular venipuncture was performed using a 16 guage, 45mm over the needle intra venous cannula connected to a 10ml syringe with heparinised saline (about 3-4 ml) to avoid clotting or air embolism and to facilitate easy handling of catheter unit. Ipsilateral pressure at the root of the neck was required at times to make external jugular vein prominent. A successful cannulation of the vein was confirmed by aspiration of venous blood into the syringe. Then a 45cm long, 0.089cm diameter, flexible angiographic J tipped guide wire was passed through the intravenous cannula by closely observing the electrocardiogram to recognize arrhythmias.

Failure of placement occurred when it was not possible to advance the J-tipped guide wire beyond the clavicle. The procedure was abandoned after 3 attempts of puncture.

RESULTS

100 patients of either sex admitted to Deccan College of Medical Sciences (DCMS), Hyderabad from February 2015 to November 2015 were chosen for this study. They were grouped into group I and group II of 50 patients each.

Group I: patients were chosen for central vein cannulation through internal jugular vein

Group II: patients through external jugular vein.

GROUP -1 INTERNAL JUGULAR VEIN:
Internal jugular vein cannulation was accomplished successfully in 94% of patients. The vein was cannulated at the first attempt with 89.36% success, with 6.38% success at second attempt and in three instances the vein was cannulated at third attempt with 4.25% success. However, in three patients the internal jugular vein could not be cannulated even after three attempts and the procedure was abandoned as there was difficulty in locating the vein.
All catheter tips reached intra-thoracic position with 94% success except for one catheter tip which was malpositioned into the right axillary vein without any serious sequelae, identified by the chest X-ray. Complications occurred in 3% of patients which included:

i) Two cases of pneumothorax following internal jugular vein cannulation. Both the patients experienced chest tightness, dyspnoea and cough. Breath sounds were diminished over the right hemithorax. As soon as the diagnosis was confirmed by the chest X-ray, tube thoracotomy was done. Following which patient symptoms subsided and the intercostal drainage was removed after confirmation of lung expansion by the chest X-ray after 72 hours.

ii) There were three instances of carotid artery puncture. Puncture of the carotid artery resulted in right paratracheal hematoma in two patients. However, no significant complications were noted in these patients whom carotid artery was inadvertently punctured.

GROUP II: EXTERNA L JUGULAR VIEI N
External jugular vein catheterization yielded 80% success rate. The vein was cannulated at the first attempt with 90% success and at second attempt with 10% success. However, in 20% of the patients, the external jugular vein could not be cannulated as there was difficulty in advancing the J-tipped guide wire beyond the clavicle. The procedure was abandoned after three attempts, as the guide wire could not be advanced even after manipulation to pass the venous bifurcation. All the catheter tips reached an intra-thoracic location with 97.5% success except for one catheter tip which was malpositioned into the ipsilateral internal jugular vein without any significant complications. Upon confirmation of catheter tip malposition by chest X-ray, the central venous catheter was repositioned into the central vein. Complications were noted in 7.5% of the patients which included three instances of hematoma formation at the puncture site without any significant sequelae.

DISCUSSION
This prospective study compared the usefulness, reliability and hazards of the popular percutaneous cervical routes for central venous placement. The location and technique for placing "central venous" cannula are numerous. Popular sites for the procedure are the internal and external jugular veins. The reason for this preference is related to its consistent, predictable anatomical location within palpable land marks. Seldingleffte technique was chosen because of its simplicity, safety and also the need to repuncture the vein is obviated.

In the present study, of the 50 patients in whom internal jugular vein was cannulated, success rate was 94%. Three patients had short neck and land marks were obscured because of obesity. In these three patients cannulation of internal jugular vein was not achieved despite three attempts, after which the procedure was abandoned.

The success rate in internal jugular vein cannulation in our study was similar to that reported by Belani, KG and Buckley, JJ et al. (1980)[5] and our observations also correlates with the Jerniger, WR et al. (1970) [6] describing the ease and reliability of cannulation of jugular vein for central venous access. During the internal jugular vein cannulation, we encountered two cases of tension pneumothorax which was confirmed by chest x-ray. These patients required intercostal drainage. In both the cases, repeated attempts [i.e. 3 attempts] were made to cannulate the internal jugular vein. It is our belief that this complication could have been avoided by proper and strict adherence to the technique. Similarly, Belani, KG and Buckley, JJ et al. [5] had encountered a case of tension pneumothorax which they attributed to direct cannulation of internal jugular vein with long over the needle catheter.

We observed three instances of inadvertent carotid artery puncture and formation of hematoma at the puncture site. Application of constant pressure at the puncture site stopped the bleeding and there were no serious
sequelae. In majority of instances, the carotid artery puncture is due to its close proximity to jugular vein. This could be eliminated by strict adherence to the technique. Civetta et al and Prince et al[7], recommended localization of the internal jugular vein, with a fine needle followed by final puncture with a large needle for catheter introduction to reduce the incidence of inadvertent carotid artery puncture. However, there were no delayed complications in our study unlike Belani, KG and Buckley JJ et al[8] who reported a incidence of hydrothorax and pulmonary infiltrate. They believed that these delayed complications were due to late penetration of the vein wall by the migrating catheter tip. Similar complications were reported by Carvell and Pearce. Benotti et al pointed out that the cause for this late penetration of the vein could be due to enhanced susceptibility of internal jugular vein catheter to motion within the vein.

With external jugular vein catheterization in our study, success rate was 80%. In remaining 20% of cases, external jugular vein cannulation was unsuccessful. This could be due to the venous plexus just above the clavicle, acute angulation of the vein and also might be due to presence of venous valves. Our results correlates with Blitt et al who encountered similar incidence of failure rate and implicated venous plexus in their inability to advance the J-tip guide wire into the external jugular vein. One instance of catheter tip malposition was encountered in our study into the ipsilateral internal jugular vein which was identified in the chest X-ray following external jugular vein cannulation.

Study by Agarwal et al on success rate and safety of internal jugular vein found that the success rate of IJV cannulation was 100%. In 809 (82.9%) patients, cannulation was performed in the first attempt. Residents performed 792 cannulations and the consultants performed 184 cannulations. In 767 patients, the residents were successful in inserting the catheter and in 25 they failed after 5 attempts, hence, they were cannulated by the consultant. The time taken for insertion of the catheter was 6.89 ± 3.2 minutes. Carotid artery puncture was the most common complication, it occurred in 22 (2.3%) patients.[8]

Another study by M. Koroglu et al on percutaneous placement of central venous catheters observed that Catheter placement was successful in all patients in group 2 and unsuccessful in 1 (2.5%) patient in group 1. All catheters functioned adequately and immediately after the placement (0% initial failure rate) in group 2, but 3 catheters (7.5% initial failure rate) were non-functional just after placement in group 1.[9] Thus comparing the two routes of central venous cannulation, there are significant differences in the results obtained. Internal jugular vein is the vein of choice for central venous access as it is subject to almost no anomalies or positional variations. It can be cannulated quickly even in the presence of marked changes in the physiological conditions like profound shock. Although predictable and reliable in providing access to central vein, it carries great risk of complications because of its close proximity to structures which may be inadvertently punctured viz. carotid artery and pleura.

Conversely, external jugular vein catheterization appears to be safer without any serious sequelae but is less predictable for successful cannulation because of its tortuous course, presence of venous valves or due to presence of venous plexus just above the clavicle.

Table 1: Comparison of success and failure between internal and external jugular vein

<table>
<thead>
<tr>
<th>Venous access</th>
<th>No.</th>
<th>Success</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>1. Internal Jugular Vein</td>
<td>50</td>
<td>47</td>
<td>94%</td>
</tr>
<tr>
<td>2. External Jugular Vein</td>
<td>50</td>
<td>40</td>
<td>80%</td>
</tr>
</tbody>
</table>
Comparison of the rate of success and incidence of complications associated with percutaneous cervical central venous cannulation

Table 2: Catheter tip positions obtained by internal and external jugular vein routes by chest x-ray.

<table>
<thead>
<tr>
<th>Catheter tip position</th>
<th>Internal Jugular vein</th>
<th>External Jugular vein</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>1. Right atrium</td>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td>2. Superior venacava</td>
<td>37</td>
<td>--</td>
</tr>
<tr>
<td>3. Innominate vein</td>
<td>05</td>
<td>--</td>
</tr>
<tr>
<td>4. Other veins Ipsilateral</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Ipsilateral Internal</td>
<td>01</td>
<td>--</td>
</tr>
<tr>
<td>Jugular vein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ipsilateral axillary</td>
<td>01</td>
<td>--</td>
</tr>
<tr>
<td>ay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. No of failures</td>
<td>03</td>
<td>--</td>
</tr>
<tr>
<td>6. Total no of cases</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
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REFERENCES:


