

**Original Article:****Comparison of bacterial colonization of central venous catheters introduced through two different routes – a prospective, randomized, observational study**

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**ABSTRACT**

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**Background:** Central venous catheterizations are commonly used in critically ill patients and may cause different complications including infections.

**Methods:** This prospective, randomized observational study was conducted in 60 patients admitted to respiratory intensive care unit (RICU) in a tertiary care hospital to compare the incidence and character of bacterial colonization between internal jugular (IJV) and subclavian (SCV) catheterization after seven days of placing the central venous catheter.

**Results:** The incidence of catheter tip colonization (CTC) was statically higher in IJV compared to SCV ( $p = 0.030$ ) whereas, there was no significant difference in blood cultures ( $p = 0.671$ ) between the groups. The incidence of CTC and growth on blood culture increased with increase in number of attempts. Common microorganism colonizing the central venous catheters (CVCs) was non fermenting Gram negative bacteria and Klebsiella spp. Two cases of catheter related blood stream infection (CRBSI) were reported in the SCV group. Microorganisms causing CRBSI were Pseudomonas spp and *Staphylococcus aureus*.

**Conclusions:** Despite sterile precautions bacterial colonization of central venous catheter tip is seen, more in the IJV group but CRBSI was common in SCV group. Catheter tip culture positivity does not confirm infection. As the number of attempts increase there are more incidences of positive blood culture and CRBSI.

**Key words:** Central venous catheter, Catheter tip colonization, Catheter related blood stream infection

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**INTRODUCTION**

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Central venous catheters (CVC) are commonly used to manage critically ill patients. These catheters provide vascular access for the administration of fluids, medications, blood products, total parenteral nutrition (TPN) and to monitor hemodynamic status. Central venous catheterization may cause mechanical, hemorrhage, thrombosis and infectious complications (5%-26%)<sup>1</sup> like local site infection, catheter related blood stream

infection (CRBSI), septic thrombophlebitis, endocarditis and other metastatic infections.<sup>2</sup> The incidences of mechanical complications has decreased due to central venous cannulation under ultrasound guidance. CVCs have a higher infection risk than other indwelling vascular access lines. The majority of CRBSIs are associated with CVCs. This causes significant morbidity, mortality<sup>3,4</sup> and add to the health cost.<sup>5</sup> CRBSI are the first and preventable cause of nosocomial infections.<sup>6</sup> Few studies<sup>7,8</sup> indicate that the selection of site for CVC may

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predispose the patient to a different risk of CRBSI. The CRBSI can be effectively treated if the initial empirical antibiotics can target the microbial organism that commonly colonise the catheter tip. We have made an attempt to find out the incidence and type of catheter tip colonization in our hospital while using two commonly preferred sites for central venous catheterization (subclavian and internal jugular vein).

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### MATERIAL AND METHODS

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A prospective, randomized and observational study was conducted in 60 patients admitted to the respiratory intensive care unit (RICU) requiring central venous catheterization, allocated into two groups as group internal jugular vein (IJV) and group subclavian vein (SCV) of 30 in each group. The study was approved by the Institutional Ethics Committee and written informed consent was taken from the patient's attendants after explaining about the study. Standard 7 Fr size radio opaque polyurethane double lumen catheters (Edward) without antimicrobial-coating were used for the study. The placement and maintenance of catheters were performed under strict aseptic precautions by use of large sterile drapes around the insertion site, surgical antiseptic hand wash, sterile gown, gloves, mask and cap. The skin insertion site was first disinfected with 10% povidine iodine which was allowed to dry, then spirit was applied for one minute. In all patients, the catheters were percutaneously inserted using Seldinger technique with electrocardiogram (ECG) and pulse oximetry monitoring of arterial oxygen saturation (SPO<sub>2</sub>) and fixed to the skin with 2-0 silk suture. After the catheter insertion, the area surrounding the catheter was cleaned with sterile gauze soaked with povidine iodine and a dry sterile gauze occlusive dressing covered the site. Strict asepsis was adhered to while accessing the CVCs at any time by the physician as well as nursing personnel. Catheter dressings were

changed every 48 hours and connecting lines were changed at every 72 hour intervals under strict aseptic precautions. Total parental nutrition (TPN) was not used in any of these cases through the CVC. The catheter was removed after one week, under strict aseptic precautions.

Upon withdrawal of the catheter, distal 5 cm was cut with a sterile surgical blade and inserted into a sterile culture tube container and transported immediately to the Department of Microbiology, where the necessary tests were conducted. Simultaneously percutaneous sample of blood was sent for culture and sensitivity. In the laboratory, under standard conditions catheter segment was cultured on 5% sheep blood agar, using a semi-quantitative technique (SQC).<sup>9</sup> Each catheter segment was transferred from the transport tube on to the surface of the blood agar plate and using a flamed forceps rolled back and forth 4 to 5 times across the agar surface and plate is incubated over night at 37 °C. Growth of more than 15 colony forming units (CFU) for the roll plate sample on blood agar was considered as significant and positive for catheter tip colonization. Growth less than or equal to 15 was considered as not significant. After the roll plate inoculation, the catheter segment was immersed in 2 mL of normal saline and vortexed for 2 to 3 min. Inoculums from the fluid was then cultured with calibrated loop on blood agar and Mac Conkey's agar overnight and colony count was done. A count of 10<sup>3</sup> CFU/mL or more was considered as significant<sup>10</sup>. The type of organism was identified by routine tests. For each catheter inserted, type of organism isolated with significant colony was recorded and antimicrobial susceptibility was performed to various antibiotics. Laboratory results were collected after 48 to 72 hours for catheter tip and 7 days for blood cultures. Catheter related

infection (CRI) was defined according to catheter tip colonization. Catheter tip colonization was significant when growth of microorganisms was > 15 colony forming units characterized by significant growth of a microorganism on the catheter but no growth in blood cultures. CRBSI was defined as isolation of same microorganism from a semi quantitative or quantitative culture of a catheter segment and from the blood (preferably drawn from a peripheral vein) of a patient, accompanied by clinical symptoms of blood stream infection without any other apparent source of infection.

## RESULTS

In our study 60 patients aged between 18-60 years requiring central venous cannulation were included and randomized into IJV and SCV groups of 30 patients in each group. The mean age in IJV and SCV group were  $32.2 \pm 13.8$  and  $38.2 \pm 15.5$  years respectively ( $p=0.120$ )

(Table 1). In IJV group there were 17 males compared to 15 males in SCV group ( $p=0.796$ ).

Among 30 central venous catheters in each group, tip cultures were positive on SQC in a significantly higher proportion of patients in IJV group compared to SCV group (15/30 Vs 7/30;  $p=0.030$ ). The number of positive blood culture was three (10%) and four (13.3%) in the IJV and SCV group respectively ( $p=0.6710$ ) (Table 2). Fourteen patients of IJV and 11 patients of SCV group required a second attempt for cannulation. The incidence of catheter tip colonization and blood culture positive was high with second attempt (Table 3). There was a significant difference in catheter tip colonization between first and second attempt in SCV group ( $p=0.004$ ) and first attempt between the groups ( $p=0.011$ ). The most common microorganism colonizing the CVCs were Gram negative bacilli (Table 4) which include Klebsiella spp, non-fermenting

**Table 1: Baseline patient characteristics**

|                                    | IJV<br>(n=30) | SCV<br>(n=30) | p-value |
|------------------------------------|---------------|---------------|---------|
| Age (years)*                       | 32.2±13.8     | 38.2±15.5     | 0.120   |
| Gender (Male:Female)               | 17:13         | 15:15         | 0.796   |
| Diagnosis                          |               |               |         |
| Snake bite                         | 2             | 0             |         |
| Supravasol poisoning               | 4             | 7             |         |
| Organophosphate compound poisoning | 12            | 9             |         |
| Alprazolam poisoning               | 0             | 1             |         |
| Unknown poisoning                  | 1             | 1             |         |
| Neurological deficit               | 9             | 11            |         |
| Obesity hypoventilation syndrome   | 1             | 0             |         |
| Renal failure                      | 1             | 1             |         |

\* expressed as mean  $\pm$  standard deviation

IJV = internal jugular vein; SCV = subclavian

**Table 2: Comparison of catheter tip culture with blood culture between the groups**

| Site                          | IJV<br>(n=30) | SCV<br>(n=30) | p-value |
|-------------------------------|---------------|---------------|---------|
| Catheter tip culture positive | 15 (50%)      | 7(23%)        | 0.030   |
| Blood culture positive        | 3(10%)        | 4(13.34%)     | 0.671   |

IJV = internal jugular vein; SCV = subclavian

**Table 3: Comparison of catheter tip culture positivity and blood culture positivity in relation to number of attempts between groups**

|                               | IJV<br>(n=30) | SCV<br>(n=30) | p-value |
|-------------------------------|---------------|---------------|---------|
| Catheter tip culture positive |               |               |         |
| 1 <sup>st</sup> attempt       | 7 (23.3%)     | 1 (3.4%)      | 0.011   |
| 2 <sup>nd</sup> attempt       | 8 (26.7%)     | 6 (20%)       | 1.000   |
| p-value                       | 0.715         | 0.004         |         |
| Blood culture positive        |               |               |         |
| 1 <sup>st</sup> attempt       | 1 (3.3%)      | 1 (3.4%)      | 0.571   |
| 2 <sup>nd</sup> attempt       | 2 (6.7%)      | 3 (10%)       | 0.288   |
| p-value                       | 1.000         | 0.126         |         |

IJV = internal jugular vein; SCV = sub clavian

Gram negative bacteria, *Pseudomonas* spp, *Proteus*, *E.coli* and *Moraxella*. The other organisms isolated are Gram positive which included *Micrococcus*, *S.aureus*, Coagulase negative *Staphylococcus*, *Citrobacter*, mixed organisms including Gram-positive, Gram-negative organisms and *Candida albicans*. There was no significant difference in the type of micro organisms isolated between the groups.

### DISCUSSION

The incidence and morbidity caused due to infection of peripheral venous catheters is low

compared to central venous catheters<sup>9</sup> especially those placed in an intensive care unit (ICU). In ICU, central venous access is required for long periods, for administration of drugs, fluids, blood products and blood sampling with frequent manipulation due to which there is increased chances of hospital acquired infections.

There are many studies which have compared central venous catheter related infection (CRI) which includes CTC and CRBSI between three different central venous cannulation sites (femoral, IJV, SCV).<sup>11-13</sup> But in our study we

**Table 4: Comparison of catheter tip culture positivity and blood culture positivity in relation to type of organisms between groups**

| Variable  | IJV<br>(n=30) | SCV<br>(n=30) |
|---|---------------|---------------|
| Catheter tip culture positive (n=22)                        |               |               |
| Gram-positive   | 2             | 0             |
| Gram-negative   | 12            | 5             |
| Mixed   | 1             | 2             |
| Blood culture positive (n=07 of the 22 CTC positive cases)* |               |               |
| Gram-positive   | 2             | 2             |
| Gram-negative   | 1             | 2             |
| Mixed*  | 0             | 0             |
| Catheter related blood stream infection                     |               |               |
| Gram-positive   | 0             | 1             |
| Gram-negative   | 0             | 1             |
| Mixed   | 0             | 0             |

\*One sample showed *Candida albicans*

CTC, catheter tip culture; IJV = internal jugular vein; SCV = sub clavian

have compared CRI in IJV and SCV because femoral site has already proven to have increased incidence of infection due to high density of skin flora in groin region<sup>14</sup> and is frequently replaced by neck lines. Whereas controversy still exist between IJV and SCV.

In our study, jugular venous access shows a higher incidence of catheter tip colonization similar to other reports.<sup>15,16</sup> The catheter tip colonization was almost twice as high in the IJV group compared with SCV group (68.2% Vs. 31.8%). The higher incidence of catheter tip colonization with jugular access compared to subclavian access is probably due to various factors favoring skin colonization like proximity of the insertion site to the mouth and the oropharyngeal secretions, higher density of local skin flora due to higher local skin temperature and the difficulties in maintaining occlusive dressings.<sup>5,17,18</sup>

Out of the 7 cases with positive blood culture (3 in IJV and 4 in SCV group) only 2 cases of CRBSI were diagnosed in our study and both patients belong to SCV group. Only 2 out of 22 patients with colonization of CVCs tips had CRBSI, suggesting an infected catheter may not always lead to CRBSI. Hence, in our study incidence of CRBSI was more in SCV group compared to IJV group which was similar to observations reported in another study.<sup>19</sup> Few investigators<sup>7,8,20</sup> reported a higher incidence of CRBSI in IJV group compared to SCV group where as others<sup>21-24</sup> did not report any such difference in CRBSI rate between IJV and SCV site. There was no case of catheter related local infection which includes induration, erythema or purulent discharge.

In our study, 35 out of 60 catheters were placed in single attempt, remaining 25 in second attempts. Of these, 8 and 14 from the first and second attempt respectively showed catheter tip colonization. Among these blood cultures were positive in 3 from first attempt and 4 from second attempt. Two cases of CRBSI reported

where also cannulated in second attempt. Though there is no significant difference in CTC and blood cultures with the number of attempts in both groups still there is an increase in incidence of infection as the number of attempts increased similar to observations in another study.<sup>25</sup>

In our study, we changed CVCs once every 7 days because in several studies, central venous catheterization longer than 5 to 7 days were associated with a higher risk of catheter related infection<sup>18,25</sup> and in other studies, CVCs were routinely changed every 7 to 10 days.<sup>26,27</sup> The risk of infectious complications with CVCs has also been reported to be more with increased duration of use.

In our study the proportion of Gram negative isolates (77.2%) compared with Gram positive (9.1%) and mixed (27.3%) was much higher than that reported in western hospitals<sup>28,29,30</sup> but in accordance with similar studies from India.<sup>31,32</sup> There is no significant difference between Gram positive and Gram negative isolates between the IJV and SCV groups ( $p=0.265$ ). *Klebsiella spp*, Non fermentative Gram negative bacteria, *Pseudomonas spp* and *E.coli* were the common organisms colonizing the CVCs in our study. The organism isolated in CRBSI is *Pseudomonas spp.* and *S.aureus*.

Limitations of our study include small sample size, length of catheter fixation was not constant, and analysis of catheter tip was done on the seventh day, antibiotic coverage was not uniform for all patients different antibiotics were used depending on the condition of the patient and patients with diabetes mellitus were not excluded from our study.

Our observations suggest that gram negative microbial organisms are more common to get colonized at central venous catheter tip irrespective of their site of placement but IJV catheters are more prone to get colonized with microbes compared to catheters placed through the SCV route.

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