

# A Comparative Study of the Feasibility of External Jugular Vein Cannulations versus Internal Jugular Vein Cannulations in Patients Undergoing Elective Surgical Procedures

ZULFIQAR ALI<sup>1</sup>, ABDUL WAHEED MIR<sup>2</sup>, SHAHID AHMAD MIR<sup>3</sup>, NELOFAR HASSAN<sup>4</sup>, ABRAR AHAD WANI<sup>5</sup>



## ABSTRACT

**Introduction:** The Internal Jugular Vein (IJV) and subclavian vein cannulations are mainly performed in daily clinical practice. Although success rates for IJV and subclavian veins are high, still the complications are not infrequent. The External Jugular Vein (EJV) approach to the subclavian vein is less taught and less practiced. The fear of frequent failures has discouraged the practitioners from using this approach.

**Aim:** To compare the success rate, number of attempts, and complications associated with IJV and EJV catheterisations.

**Materials and Methods:** A total of 160 patients, requiring central venous catheterisation for various surgical procedures were randomly divided into two groups. Patients in group I (n=80) underwent right IJV catheterisation and patients in group E (n=80) underwent right EJV catheterisation. The number of

attempts for cannulation, success or failure of catheterisation and any complications associated with the procedure or in the post-operative period were noted in each group. The data was compared between the two groups by using Chi-square test and Student's Independent samples t-test.

**Results:** The right IJV was successfully cannulated in 90% while as the right EJV was successfully cannulated in 70% of the patients ( $p < 0.05$ ). All cannulations were done by the same anaesthesiologist. Malpositioning of catheter was noted in eight patients in Group E while five patients had malpositions in Group I. Pneumothorax was encountered in two patients, and carotid artery puncture in three patients from group I.

**Conclusion:** The rate of success for IJV was better than the EJV. The complication rate of pneumothorax and carotid artery injury was more with IJV than EJV.

**Keywords:** Central venous cannulation, Complications, Seldinger technique

## INTRODUCTION

Central Venous Catheter (CVC) cannulations are practiced routinely in major surgical procedures for infusion of intravenous fluids, administration of inotropes, central venous pressure monitoring and diagnosis and treatment of air embolism [1]. The IJV and subclavian vein cannulations are mainly performed in daily clinical practice. The most common complications encountered with IJV cannulations are carotid artery puncture and pneumothorax [2]. Though the incidence of carotid artery cannulations with subclavian vein cannulations is rare, pneumothorax has been reported frequently. Though it is common practice to use the EJV for peripheral venous cannulation the use of a CVC in EJV is relatively neglected and should be used more often [3].

A catheter-through-cannula design for external vein cannulation was found to be better than catheter through needle approach (central placement rates were 72% and 60% for catheter through cannula and catheter through needle, respectively). Complications were fewer in both the approaches and never serious [4]. A single prominent EJV is seen in approximately 90% of the people arising at the angle of the jaw, arising from smaller tributaries in the face and scalp. It then courses obliquely and superficially across the Sternocleidomastoid (SCM) muscle and terminates beneath the clavicle in the subclavian vein. The presence of valves and venous plexuses may cause problems in threading catheters into the EJV. The vein is only loosely fixed in the subcutaneous tissues and is not easily distensible; thus venipuncture of EJV may be often difficult.

The EJV approach to the subclavian vein is less taught and less practiced than the approach to the IJV and subclavian vein. The fear of frequent failures has discouraged the practitioners from

using this approach. There are studies in which EJV cannulations are described with a good success rate and minimal complications [5,6]. This study was designed to assess the feasibility of routine cannulation of EJV in clinical practice.

In this study, the success rate, number of attempts, and complications associated with the IJV were compared with the EJV catheterisations.

## MATERIALS AND METHODS

This prospective observational study was conducted at Sher-I-Kashmir Institute of Medical Sciences Soura, Srinagar, Jammu and Kashmir, India, from December 2018 to December 2019. An informed consent was taken from all the participants, after explaining the main objectives of the study and the possible complications associated with the procedure.

The study was purely observational in nature. The authors routinely put central lines in all major surgical patients. The practice is that the lines are placed in EJV, IJV and subclavian vein. This study merely compiled the data that was encountered while routine cannulation of these cases. No additional intervention was planned (except what is practised in daily clinical care). Hence no Institutional Ethics Committee clearance was sought for. However, the Helsinki guidelines were followed during the study.

The sample size was calculated after taking anticipated success rate of EJV at 98% [7] and the success rate of IJV cannulation using anatomical landmarks at 85% [8]. With an alpha error of 0.05, power of 80% and enrolment ratio of 1 a total sample size of 142 was needed with 71 patients in each group. To compensate for the drop out a total of 160 patients were taken with 80 patients in each group.

**Inclusion criteria:** A total of 160 patients, requiring CVC for various surgical procedures were included in the study.

**Exclusion criteria:** Infection at puncture site, deranged coagulation profile, contralateral pneumothorax, trauma to clavicle and upper ribs, distorted anatomy of the neck or clavicle and cervical spine trauma.

All patients were subjected to detailed clinical history, and a complete general physical and systemic examination. Routine investigations such as complete haemogram, kidney function tests (serum urea, serum creatinine), liver function tests (serum albumin, serum bilirubin, alkaline phosphatase, Serum Glutamic Pyruvic Transaminase (SGPT), Serum Glutamic Oxaloacetic Transaminase (SGOT)), urine examination, coagulation profile, electrocardiogram and chest X-ray (PA view) were carried out in all the patients.

The patients were randomly divided into two groups, by sealed envelope technique. Patients in group I (n=80) underwent right IJV catheterisation and patients in group E (n=80) underwent right EJV catheterisation. All cannulations were done by the same anaesthesiologists who had more than 10 years of experience.

The two groups were studied with respect to the success or failure to do IJV or EJV cannulations, number of attempts, and any complications associated with the procedures. A certofix trio V 715 (7 french gauge 15 cm) central line (B Braun) was used. Each skin puncture was defined as an attempt. A maximum of three attempts were allowed for either approach. In case a failure to cannulate EJV, an attempt was made to catheterise the IJV while in case of failure to cannulate the IJV an attempt was made to cannulate the subclavian or EJV depending on the comfort of the attending physician.

A chest radiograph was done in all patients in the post-operative period to confirm the position of CVC and the development of any complication as pneumothorax or haemothorax. All CVC were done by the same anaesthesiologist who had more than 10 years of experience.

Patients were placed in supine position with head turned to the left side, with a towel roll placed in between interscapular region. The anterolateral portion of the neck was cleaned with povidone-iodine solution followed by an alcohol based solution. The procedure site was draped with a sterile towel. In IJV approach, a landmark technique was used via the anterior approach. The triangular area at the base of the neck created by the separation of the two heads of the SCM muscle was identified. The carotid artery pulse was located in this triangle; by palpation. The carotid artery was gently retracted towards the midline and away from the IJV. The probe needle was then inserted at the apex of the triangle (with bevel facing up) and the needle was advanced toward the ipsilateral nipple at a 45° angle from the skin. If the vein was not entered by a depth of 5 cm, the needle was drawn back and advanced again in a more lateral direction. During the cannulations of the EJV, with the patient in supine position, the head was rotated to the left and the anterior border of the right SCM muscle was identified. The EJV was then identified as it crossed the SCM. Venous distension was achieved by a second operator who placed a forefinger parallel and immediately superior to the clavicle, where the EJV dives beneath the clavicle. The probe needle was then passed into the EJV till free aspiration of the blood was obtained. At this juncture the guidewire was passed. In case of free passage of guidewire, the central venous catheter was threaded over the guide wire. If there was a resistance to the path of the guide wire, the procedure was abandoned and alternative route of CVC was attempted.

A modified Seldinger technique was used for all cannulations. The optimal length of the catheter was determined by overlaying the catheter from the puncture site to second intercostal space.

## STATISTICAL ANALYSIS

SPSS version 15.0 was used. Chi-square test was used for comparing qualitative variables, while the student's independent samples t-test was used to compare means. A  $p \leq 0.05$  denoted significance.

## RESULTS

There was no statistically significant difference in the demographic profile of the two groups [Table/Fig-1]. It was observed that most (77.5%) of the IJV cannulations were performed successfully without any complications in the first attempt. However, there was a lower rate of success with EJV cannulations. The most common cause of failure with EJV cannulations was inability of the guidewire to pass on its way to superior vena cava, possibly due to bicuspid venous valves and inherent angulations along its passage. It was observed that 63.75% cannulations were possible on first attempt in the EJV. Thirty percent of the patients could not be cannulated in the EJV while as only 10 % of patients could not be cannulated in the IJV [Table/Fig-2]. In case a failure to cannulate EJV, an attempt was made to catheterise the IJV while in case of failure to cannulate the IJV an attempt was made to cannulate the subclavian or EJV depending on the comfort of the attending physician.

Demographic data	Group E N=80	Group I N=80	p-value
MF:ratio	3:1	3.7:1	0.38
Age (years)	54.54±9.33	56.17±7.19	0.21
Weight (kg)	65.19±6.21	66.24±7.33	0.32
Height (cm)	158.21±7.25	160.18±8.36	0.11

[Table/Fig-1]: Demographic profile.

Group E: External jugular vein cannulations, Group I: IJV cannulations, NS: Not significant

Attempts	Group E		Group I	
	N=80	Percentage	N=80	Percentage
First	51	63.75	62	77.5
Second	4	5.00	7	8.75
Third	1	1.25	3	3.75
Unsuccessful	24	30.00	8	10.00

[Table/Fig-2]: Frequency distribution of number of attempts.

Pearsons chi-square: 10.88; p: 0.012. The result is significant at a p-value  $\leq 0.05$ . Group E: External jugular vein cannulations, Group I: IJV cannulations

Comparison of overall successful and failed attempts is given in [Table/Fig-3] and the overall complication rate is given in [Table/Fig-4].

Result	Group E		Group I	
	N=80	Percentage	N=80	Percentage
Successful	56	70	72	90
Failure	24	30	8	10

[Table/Fig-3]: Comparison of successful attempts of external jugular vein and IJV (n=160).

Pearsons chi-square: 12.35; p: 0.00044. The result is significant at a p-value  $\leq 0.05$ .

Group E: External jugular vein cannulations, Group I: IJV cannulations

## DISCUSSION

Central lines are commonly used for administration of intravenous fluids and inotropes during various surgical procedures. Subclavian and the IJVs are commonly practiced while as femoral vein is rarely used for cannulations because of the increased chances of infection associated with it. No study was found that

Complication	Group E		Group I	
	Numbers	Percentage	Numbers	Percentage
Malposition	8	10	5	6.25
Pneumothorax	0	0	2	2.50
Carotid artery puncture	0	0	3	3.75

**[Table/Fig-4]:** Comparison of complications in two groups.

Group E: External jugular vein cannulations, Group I: IJV cannulations.

Malpositions were common with external jugular vein cannulations, while as pneumothorax and carotid artery puncture was seen frequently with IJV cannulation

compared the ease of cannulation of EJV with IJV. To the best of our knowledge, this is the first study that has attempted to compare to study the ease of cannulation and the associated complications between EJV and IJV. The EJV is underutilised in clinical practice because of the frequent failures associated with guide wire insertion [5,6]. Various anatomical factors may lead to difficulty in cannulations of EJV as the presence of two bicuspid venous valves, one at the junction of subclavian, the other approximately 4 cm upstream [9] and the presence of a terminal end of a venous plexus instead of a single channel in about 4% of the patients [10,11].

Various body manoeuvres have been attempted to facilitate the passage of guide wire and improve the success of EJV cannulations [7]. Though the subclavian vein has been found to have an ease for insertion, a negligible complication rate of carotid artery cannulations and an increased level of patient comfort, it may be associated with the occurrence of a pneumothorax, haemothorax, subclavian artery puncture and haematomas at the puncture site. Delayed complications as catheter embolisation, venous thrombosis, endocarditis, myocardial perforation and pulmonary embolus have been reported [12]. It may be also associated with a lower incidence of catheter related infection and thrombosis than femoral or IJV cannulations [13]. The major advantages of EJV are, negligible rate of complications, in terms of carotid artery puncture and the development of pneumothorax.

The primary aim of the present study was to compare the success rate, number of attempts, and complications associated with the IJV with the EJV catheterisations.

Most of the IJV cannulations were performed successfully (with ease) in the first attempt, in this study. However, only 70% EJV cannulations were performed successfully in the first attempt. Out of the 56 patients who had a successful EJV placement, it was seen that malpositions occurred in 8 patients (10%). All the patients with successful CVC (with no misplacement) had a satisfactory CVP trace whereas in 8 patients with misplacements of the central venous line did not have a satisfactory CVP trace. It could have a result of the extrathoracic placement of the CVP line.

During the percutaneous central venous catheterisation through the EJV in children [14] the incidence of local neck haematoma was 7% in contrast to the present study where in none of the patients had developed any localised neck haematomas. This may have been as a result of a single physician (with more than 10 years of experience who was involved in the cannulations of EJV) in the present cases. The incidence of misplacement in present study was 10% which was similar to the study done by Cruzeiro PC et al., who found the incidence of misplacements at 12.5% [14].

The success rate of CVC from EJV has been reported to range from 73% to 100% in various studies [3,15]. The success rate in the present study was 70% with a failure rate of 30%. This was comparable to the failure rate that has been mentioned by Magoon R et al., (success rate of 80%), Lahtinen P et al., (success rate of 68%) and Mitre CI et al., (success rate of 80% from surface anatomy group and 73% without the use of surface anatomy using ultrasound) [7,16,17].

Though the presence, of various anatomical factors such as presence of two bicuspid venous valves, and presence of venous plexus instead of a single channel at the terminal end may contribute to the failures, during EJV cannulations, still it remains a safe alternative in a majority of patients with coagulopathy. Also the incidence of carotid artery puncture [18], subclavian artery puncture [12,18], pneumothorax [19-21] and haemothorax [19-21] is negligible with EJV.

### Limitation(s)

This study was a single centric trial with only one physician involved in the central venous cannulation. The same results may not be reproduced in a multicentric trial with the involvement of multiple physicians. All patients in this study were adult patients. The results cannot be extrapolated to the paediatric population. Large scale multicentric trials need to be done to confirm the results of the present study.

### CONCLUSION(S)

The rate of success for IJV was better than the EJV. The complication rate of pneumothorax and carotid artery injury was more with IJV than EJV. The malpositions of central venous cannulations were more common with EJV cannulations.

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#### PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Anaesthesiology and Critical Care, Sheri Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India.
2. Associate Professor, Department of Anaesthesiology and Critical Care, Sher-I-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India.
3. Senior Resident, Department of Anesthesiology and Critical Care, Sher-I-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India.
4. Physician Specialist, Department of General Medicine, Government Gousia Hospital, Srinagar, Jammu and Kashmir, India.
5. Professor, Department of Neurosurgery, Sher-I-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India.

#### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Zulfiqar Ali,  
27, Nabdi Pora Hawal, Srinagar-190011, Jammu and Kashmir, India.  
E-mail: zulfiqaraliiii@yahoo.com

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