Original Article

Randomised controlled trial of central venous catheterisation through external jugular vein: A comparison of success with or without body manoeuvres

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Access this article online

Website: www.ijaweb.org

DOI: 10.4103/ija.IJA_423_17

Quick response code

ABSTRACT

Background and Aims: The external jugular vein (EJV), often used for resuscitation, has been underutilised for central venous catheterisation (CVC) in view of an unpredictable success rate. There is an encouraging literature on the improved success rate of CVC through EJV with the inclusion of certain body manoeuvres. This prospective randomised controlled study was conducted with the aim of evaluating the efficacy of body manoeuvres in improving the success rate of CVC through EJV. **Methods:** One hundred patients aged 18–50 years, scheduled for elective surgery requiring CVC, were randomly assigned to either undergo CVC using Seldinger technique with body manoeuvres or a control group undergoing CVC without body manoeuvres. The primary outcome was the success rate of CVC, as observed in the post-procedure chest radiograph. Secondary outcomes included quality of central venous pressure waveform, catheterisation attempts, total time for CVC, complications. **Results:** CVC was achieved in 98% (49/50) of patients in study group and 80% (40/50) of patients in control group (P = 0.008). Mean catheterisation time was significantly lower in the study group (151.06 ± 40.50 s) compared to control group (173.50 ± 50.66 s) (P = 0.023). The incidence of catheter misplacement and failure to cannulate were lower in the study group (0%, 2% vs. 20%, 12.5%, respectively). Groups did not differ in a number of catheterisation attempts and incidence of haematoma. **Conclusion:** Inclusion of various body manoeuvres to Seldinger technique significantly improves the success rate of CVC through EJV.

Key words: Central venous catheterisation, external jugular vein, Seldinger technique

INTRODUCTION

Central venous catheterisation (CVC) is an essential feature of patient management in perioperative medicine and critical care, given the wide range of applications from haemodynamic monitoring to prolonged vascular access.[1] CVC is conventionally approached through an internal jugular vein (IJV) or subclavian vein (SCV), but these approaches may be associated with various morbidities.[2,3]

For safe CVC, the perioperative physicians need to be more innovative in approach, especially in patients receiving anticoagulants. CVC through an external jugular vein (EJV) is a recognised technique.[4] This approach carries fewer risks, but the success rate varies.[5] Various body manoeuvres have been described in the literature to help overcome the anatomical

How to cite this article: Magoon R, Malhotra SK, Saini V, Sharma R, Kaur J. Randomised controlled trial of central venous catheterisation through external jugular vein: A comparison of success with or without body manoeuvres. Indian J Anaesth 2017;61:985-9.

constraints in the smooth passage of guidewire through the vein.[6] The present study was conducted to evaluate the efficacy of various body manoeuvres in improving the success rate of CVC through EJV when combined with Seldinger technique.

METHODS

A prospective, randomised controlled study of a total of 100 American Society of Anaesthesiologists physical status I-II patients in 18–50 years age group requiring CVC preoperatively, was conducted after obtaining approval from the Institute Ethics Committee and written informed consent from the patients. The patients were randomly allocated into two groups using a computer-generated random table, into the study group ($n = 50$) who underwent CVC through the EJV with the help of body manoeuvres and the control group ($n = 50$) who underwent CVC without the body manoeuvres.

The patients with overlying skin infection, EJV thrombophlebitis, ipsilateral thrombosis of the EJV or SCV, clinical coagulopathy or laboratory anomaly of haemostasis (Platelet count <1,00,000/mm^3 or activated partial thromboplastin time >1.5 times the control or INR >1.5, known or suspected cervical spine injury, neck mass, cervical haematoma, anatomical distortion, non-palpable or not visible EJV, undergoing the head and neck surgery were excluded from the study.

In both the groups, after initial venepuncture with the patient in a Trendelenburg position, catheterisation was performed by the Seldinger Technique. The smooth passage of the guidewire beyond the clavicle, with the subsequent insertion of the central venous catheter (Certofix Mono, B-Braun, Melsungen AG, Germany), defined successful CVC. The central venous catheter was advanced further to reach the level of 4th rib approximately, which marks the junction of superior vena cava-right atrium (SVC-RA). In the study group, the body manoeuvres on the patient were performed by an assistant anaesthesiologist in the following sequence till the successful insertion of the central venous catherer:

Manoeuvre I: Anterior rotation of the shoulder with a downward traction.

Manoeuvre II: Abduction of the ipsilateral arm.

Manoeuvre III: Internal rotation of arm with upward pressure on the scapula.

The first attempt at CVC in the study group was performed in the background of the manoeuvre I. The three manoeuvres were sequentially applied in the following attempts of achieving CVC, with the successive manoeuvre performed with the neutralisation of the preceding. A maximum of three attempts were allowed in both the groups and the procedure was abandoned at any time there was an evidence of any haematoma or any other complication such as signs of air embolism, pneumothorax or arterial bleeding. In the cases where we failed to achieve CVC through EJV, ipsilateral or contralateral IJV or SCV was cannulated.

The patients with the successful passage of the catheter through the EJV had their line transduced for waveform analysis. Satisfactory central venous pressure (CVP) waveform was defined by the presence of appreciable venous waves at a scale of 30 mmHg after appropriate zeroing and levelling. Any numerical value of CVP in the absence of a discernible CVP trace was disregarded. The patients were subjected to a post-procedure chest radiograph at the end of the surgery to determine the catheter position. The two groups were compared with regard to the rate of successful cannulation, and the position of catheter, quality of CVP waveform, number of catheterisation attempts, total procedure duration (calculated from initial venepuncture to successfully securing the line) and complications such as haematoma, catheter tip misplacement or failure to cannulate.

The sample size calculation was based on the previous studies evaluating the rate of successful CVC through the EJV in the background of body manoeuvres, with 80% power of the study. The statistical analysis was performed using SPSS version 17 (Statistical Packages for the Social Sciences, Chicago, IL). Normality of quantitative data was checked by measures of Kolmogorov–Smirnov tests of normality. For normally distributed data means were compared using unpaired *t*-test. For skewed data or scores Mann–Whitney test was applied. Chi-square test or Fisher's exact test was applied for categorical data. The value of $P < 0.05$ was considered to indicate statistical significance.

RESULTS

CVC through the EJV was attempted in a total of 100 patients with 50 patients each in the study and the control group from July 2013 to October 2014. The study and control groups were similar with respect to the demographic characteristics [Table 1].

Out of total 100 patients, 89 had successful catheterisation. CVC was achieved in 98% (49/50) patients in study group and 80% (40/50) of patients in control group, significantly higher in the study group ($P = 0.008$).

The mean number of catheterisation attempts (mean ± standard deviation [SD]) was 1.42 ± 0.61 in the study group and was 1.70 ± 0.81 in the control group, statistically insignificant with a $P = 0.096$. Out of the 50 cases in each group, three attempts were required in a significantly lower number of patients in the study group as compared to the control group (3/50; 11/50, respectively, $P = 0.041$). Out of the 49 successful cannulations in the study group, 32 were accomplished in the first attempt, 15 in the second attempt, two in the third attempt. In the control group out of 40 successful cannulations, 26 were achieved in the first attempt, 13 in the second attempt and one in the third attempt. The attempt based success rate is comparable between the groups, in the background of a significantly lower overall success rate in the control group [Table 2].

The total time taken to CVC in seconds was significantly lower in the study group (151.06 ± 40.49) as compared to control group (173.50 ± 50.66) ($P = 0.023$). Out of the 40 successful catheterisations in the control group, 37 had satisfactory CVP trace, i.e. 92.5%, whereas 100% (49/49) of patients with successful catheterisations in the study group had satisfactory CVP trace ($P = 0.087$) [Table 2].

In the post-procedure chest radiograph, 35 out of 40 catheters were at the junction of the SVC-RA in the control group, two were in the SCV, making total of 37 out of 40 in intrathoracic location in the control group, whereas rest three were malpositioned in the ipsilateral axillary vein. At the same time, all the 49 successfully placed catheters in the study group were at the junction of the SVC-RA. The groups were similar regarding the incidence of haematoma at the venepuncture site. The incidence of catheter misplacement and failure to cannulate was significantly lower in the study group compared to the control group ($P = 0.016$ and 0.008).

Table 1: Demographic characteristics in the two groups

Parameters	Mean±SD		*P*
	Study group	Control group	
Age (years)	41.96±8.34	40.22±9.89	0.344
Male:female	32:18	32:18	1.000
BMI (kg/m^2)	24.32±3.37	23.18±3.30	0.091
ASA I/II	24/26	30/20	0.229

BMI – Body mass index; SD – Standard deviation; ASA – American Society of Anaesthesiologists

Table 2: Comparison of the study and the control groups

Parameters	Study group (%)	Control group (%)	*P*
Overall successful CVC	49/50 (98)	40/50 (80)	0.008*
Mean CVC attempts	1.42±0.61	1.70±0.81	0.096
Requirement of third CVC attempt	3/50 (6)	11/50 (22)	0.041*
Total time to achieve CVC	151.06±40.49	173.50±50.66	0.023*
Satisfactory CVP trace if successful CVC	49/49	37/40	0.087
Postprocedure CXR			
Catheter at SVC-RA junction	49/49 (100)	35/40 (87.5)	0.016*
Catheter in axillary vein	0/49 (0)	3/40 (7.5)	0.087
Catheter in subclavian vein	0/49 (0)	2/40 (5)	0.199
Catheter in intrathoracic location	49/49 (100)	37/40 (92.5)	0.087
Complications			
Haematoma	1/50 (2)	2/50 (4)	1.000
Misplacement	0/50 (0)	5/50 (12.5)	0.016*

CVC – Central venous catheterisation; SVC-RA – Superior vena cava-right atrium; CXR – Chest X-ray; CVP – Central venous pressure, *Significant (P<0.05)

DISCUSSION

EJV, being a superficial adequately sized vein of the neck and isolated from major neurovascular structures has been used for resuscitation but highly underutilised as a method for gaining central venous access.[7] The conventional Seldinger technique[8] used alone has been of variable and unpredictable success rate while utilising EJV for CVC.[5,6,9,10]

The passage of guidewire, stiff introducer and/or catheter can be troublesome or even impossible at times. Various anatomical factors contribute to such a difficulty, with the major reason being the presence of two bicuspid venous valves, one at the junction of subclavian, the other approximately 4 cm upstream.[11,12] The terminal end is a venous plexus instead of a single channel in about 4% of the patients.[11,13] Once formed, the EJV runs in a lateral direction, potentially towards the arm rather than the thorax.[6] with inherent angulations in its passage through the cervical fascia and at the termination into the SCV.[6,14,15] At the same time, the diameter of EJV-SCV junction is: 5.5 ± 1.6 mm through which J-wire might not traverse.[12] Moreover, EJV is one of the variable veins, with the various anatomical variations been described by Yadav *et al*.[16]

We proposed that the conventional Seldinger technique be combined with the sequential use of body manoeuvres to decrease the inherent angulation at EJV confluence with IJV or subclavian vein, as the case may be, and to bring the EJV more in alignment with

the long axis of the thorax.[6,9] We intended to study the difference in success rates while catheterising EJV with or without the use of body manoeuvres.

CVC was achieved from EJV in 98% in the study group and 80% in the control group ($P = 0.008$). The success rate of CVC from EJV has been reported to range from 73% by Chakravarthy[10] *et al*. in large study to almost 100% in the smaller study by Blitt[17] *et al*. using the J-tipped guidewire. The rate of failed cannulation has been reported from 4% to 27%.[7,17] The failure rates were much lower in the study group and were in the reported range in the control group. This can be accounted by the various anatomical factors being simultaneously involved in combination with the inherent variability that may lead to difficulty and even failure of catheterisation through the EJV.

The high success rate with the use of body manoeuvres combined with the Seldinger technique for CVP line insertion through the EJV extends the available literature on the use of body manoeuvres for increasing the ease of CVC through the EJV. The mean number of catheterisation attempts have been reported to be around 1.5–1.7 catheterisation attempts per successful cannulation by Mitre *et al*.[18] In this study, the mean number of catheterisation attempts (expressed as mean ± SD) was 1.42 ± 0.61 in the study group and was 1.70 ± 0.81 in the control group, $P = 0.096$.

It was noteworthy in our study that three catheterisation attempts were required in a significantly lower number of patients in the study group when compared to the control group ($P = 0.041$). This can be explained in the light of the use of body manoeuvres which led to increased success rates with repeated number of attempts. The mean time to achieve CVC through the EJV has been reported to be around 186–194s in study conducted by Mitre *et al*.[18] The timeframe of catheterisation duration was in the above-mentioned range in both the groups.

All the patients with successful CVC had a satisfactory CVP trace in the study group whereas three out of forty patients with successful CVC in the control group did not have a satisfactory CVP trace with discernible CVP waves, a $P = 0.087$. It could have been attributed to the extrathoracic placement of the CVP line.

Out of the overall 100 patients, a total of 89 had successful catheterisation through the EJV. We obtained

Figure 1: The typical course of a CVP catheter in a case of successful central venous catheterisation through the EJV

varied forms of chest X-rays [Figure 1] due to the large number of anatomical diversities in the course and drainage of the EJV.[16] Regarding complications, the incidence of haematoma has been quoted to be around 7% by Cruzeiro[19] *et al*. whereas in our study the overall incidence of haematoma was 3% (4% in the control and 2% in the study group). The incidence of catheter malposition has been reported to be around 12% by Cruzeiro *et al*.[19] Although the incidence of misplacement was similar to the reported, i.e., 12.5% in the control group, it was significantly lower in the study group: 0% with a $P = 0.016$.

The present study does go on to show the utility of body manoeuvres not only in increasing the overall success rate but also in decreasing the rate of catheter misplacement while attempting CVC through the EJV. The study, however, has a few limitations. The principal investigator could not have been blinded to the performance of the body manoeuvres. The study has been performed in a perioperative setup. The study could have considered a more suitable definition of successful CVC, in the form of CVP waveform analysis or on-table fluoroscopy. However, the study provides a streamlined approach to perform the necessary body manoeuvres to negotiate a CVP catheter through the EJV in difficult cases.

CONCLUSION

The present study concludes that the use of a combination of established as well as newer body manoeuvres, if carried out in an appropriate manner can lead to an improved success rate of central venous cannulation through the EJV. It is proposed that this

technique can be used as an alternative or as a rescue when the classic unaided Seldinger technique fails. The high success rate, independent of all other factors attests to the versatility of classical body manoeuvres in catheterising EJV.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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