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Original Research Article

Evaluation of Cross-Sectional Area Changes by Ultrasonographic Guided Internal Jugular Vein Cannulation in Trendelenburg Position and Positive End-Expiratory Pressure Undergoing Procedure in Operation Room

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ABSTRACT

Introduction: Internal jugular vein (IJV) cannulation is commonly done using the surface landmark method and approaches by anterior, posterior and apex approach, Seldinger technique is the most commonly used technique and the incidence of unsuccessful cannulation is approximately 4 % to 12%. Ultrasound guidance technique can provide the real time view of IJV and its spatial relationship with surrounding tissues as well as advancement of needle/guide wire and most of the complications associated with blind technique can be avoided with standard of care.

Materials and Methods: Patient controlled, single blind, randomized prospective study was conducted in the Department of Anaesthesiology & Critical Care, Rama medical college hospital and research centre One hundred patients of either sex belonging to American Society of Anesthesiologists (ASA) physical status class I or II, between 18-50 years of age undergoing general anaesthesia were included in the study.

Results: After application of varying PEEP values and Trendelenburg position, the changes were observed that Heart rate increase initially (S_0 to S_5) and decreased with higher PEEP values (S_5 to S_{15}) in supine position. Both systolic and diastolic BP were found to statistically significant decrease with increasing PEEP value in supine as well as Trendelenburg position except with small PEEP values (0-5 cms of H_2O) in supine position. In both supine position and Trendelenburg position Transverse and anteroposterior diameter showed stastitically significant increase from baseline values with increasing PEEP upto 10 cms of H_2O Changes in CSA with reference to Gender, there was no statistically significant difference in the amongst male and female population, maximum statistically significant increase in CSA was upto PEEP of 10 cms of H_2O applied in 10 degree Trendelenburg position. Maximum value of CSA was 1.99 cm^2. In our study we found an increase in the percentage of CSA in supine position as well as in Trendelenburg position with applied PEEP of 5 and 10 cms of H_2O from the base line PEEP 0. Hence maximum statistically significant percentage change in CSA at T_{10}-S_0. (62.03%).

Conclusion: These finding can be useful for cannulation of RIJV in patient undergoing GA by increasing CSA of RIJV and avoiding complications without further comprising the haemodynamic status of the patient.

Keywords: Internal Jugular Vein (IJV) Cannulation, Trendelenburg Position, Positive End-Expiratory Pressure.

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INTRODUCTION

Internal jugular vein (IJV) cannulation is commonly done using the surface landmark method and approaches by anterior, posterior and apex approach. Seldinger technique is the most commonly used technique and the incidence of unsuccessful cannulation is approximately 4 % to 12%, but rate can be 35% or more in blind technique[1,2] with complications may be as high as 18% and is related to the number of needle passes. Commonest complication of IJV cannulation is carotid artery puncture.[3,4] Ultrasound guidance technique can provide the real time view of IJV and its spatial relationship with surrounding tissues as well as advancement of needle/guide wire and most of the complications associated with blind technique can be avoided with standard of care.[5] The success rate for central venous line placement correlates with the cross-sectional area (CSA) of vein. Larger the CSA, higher is the success rate of its cannulation and smaller the CSA, higher is the chances of failure with complications such as hemothorax, pneumothorax, arterial puncture etc. Therefore several manoeuvres to increase the filling and thus the diameter and CSA of the vein have been described to facilitate cannulation and reduce potential side effects. Increasing evidence suggests that ultrasound guidance reduces complications and improves the speed and overall success rate of venous cannulation. A number of ultrasound studies have been conducted to determine the cross sectional area (CSA) of the right internal jugular vein in response to various maneuvers, such as the Trendelenburg and reverse Trendelenburg, tilt position with different tilt degrees, the simulated (with 20 cms of H_2O during mechanical ventilation) and non-simulated Valsalva maneuver, hepatic compression, and several combinations of maneuvers to increase the CSA of the RIJV.[6-9] but some of the maneuvers (hepatic compression, humming tone, and Valsalva) are not practical under general anaesthesia.[6-10]

Fig 1: USG guided localizing IJV

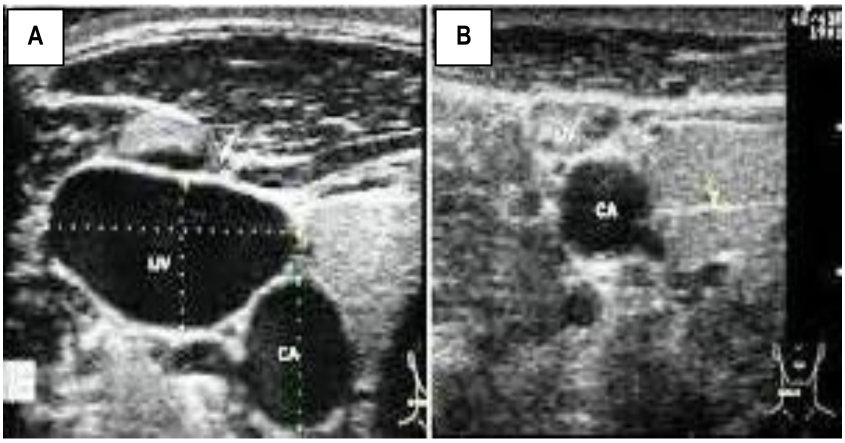

Fig 2: (A) IJV Image before compression (B) IJV collapse after compression

MATERIALS AND METHODS

This present patient controlled, single blind, randomized prospective study was conducted in the Department of Anaesthesiology & Critical Care, Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh (India). One hundred patients of either sex belonging to American Society of Anesthesiologists (ASA) physical status class I or II, between 18-50 years of age undergoing general anaesthesia were included in the study. Patients undergoing head & neck surgery, with history of neck surgery, with neck swelling and who suffer severe hypotension after induction were not included in the study. Routine investigations like Haemoglobin (Hb), coagulation profile, complete urine examination, blood urea, blood sugar, elctrocardiogram, chest x-ray and any other relevant investigation as per need were carried out and recorded. Informed written consent was obtained and patients were explained about the procedure. Non-invasive monitoring (ECG, Heart Rate, blood Pressure, Respiratory rate, Pulse oximetry), an intravenous line was secured & crystalloid drip started. Patients were explained about the procedure and informed written consent was obtained from the patients. They were premedicated with oral alprazolam 0.25 mg, ranitidine 150 mg at bedtime and in the morning at 6 am on the day of surgery. After recording the base line vital signs general anaesthesia was induced with injection glycopyrolate 0.2 mg, injection propofol 2 $mgkg^{-1}$ and injection sucxamethonium2 $mgkg^{-1}$ intravenously, Endotracheal tube of appropriate size was used to secure the airway and maintained with long acting muscle relaxation with Inj. vecuronium bromide 0.1 $mgkg^{-1}$ and isoflurane (0.8 % - 1%) in nitrous oxide and oxygen in ratio of 60:40. Ventilation was controlled with the tidal volume of 6-10 ml kg^{-1} and the respiratory rate was adjusted to maintain $EtCO_2$ value of 30-40 mmHg. After induction of anaesthesia, non-invasive blood pressure (NIBP), heart rate (HR), pulse oximetry (SPO_2)were recorded before induction (baseline), second at the time of intubation and third after 5 minutes of intubation followed by recordings in neutral control position and then with 7 different maneuvers (PEEP & Trendelenburg position, independently & combine together). All patients were brought to the neutral control condition: supine position and a zero end-expiratory pressure (S_0) and the head rotated 5° to 10° to the left side without cervical extension or a neck-rest. Single operator examined the CSA of the right internal jugular vein by using a (6 – 13MHz) ultrasound probe (Sonosite M turbo) at the level of cricoid cartilage. The transducer was placed with least possible pressure to avoid jugular compression and base line values were noted.

We then applied 7 different maneuvers in random order:
(1) a PEEP of 5 cms H_2O (S_5),
(2) a PEEP of 10 cms H_2O (S_{10}),
(3) a PEEP of 15 cms H_2O
(4) after tilting down the operating table to a 10° angle in Trendelenburg position (T_0) with PEEP of 0 cm H_2O,
(5) after 10^0 Trendelenburg position with a PEEP of 5 cms H_2O (T_5),
(6) after 10^0 Trendelenburg position with a PEEP of 10 cms H_2O (T_{10}),
(7) after 10^0 Trendelenburg position with a PEEP of 15 cms H_2O (T_{15}).
After each maneuvers, the control condition was instituted for 1 minute. The measurements of AP and Transverse diameters of right internal jugular vein were taken, 1 minute after instituting each maneuver. The CSA was then obtained from these diameters as per LOGIQ e software.
After completion of the study procedure surgery was allowed to commence with usual maintenance anaesthesia as routine.

Statistical Analysis
All the data obtained from the observations was compiled and subjected to analysis using SPSS version 18.0.
Categorical data was described as number of patient (n).and compared using Pearson chi-square/fisher exact test. For genderwise comparison, unpaired t-test was applied and for comparison between the time periods for the relative change, paired t-test was used. P-value (significance value) less than 0.05 was considered as significant. Type I error probability associated with this test of this null hypothesis was 0.05.

$$n = \frac{z^2_{1-\alpha/2}\sigma^2}{d^2}$$

α = 5% (i.e. Confidence level = 95%); d = 5%
1. Standard deviation (σ)
2. Precision required =d
3. Probability of type I error

The observations and the results obtained are discussed in the tables and graphs given below.

Table 1: Frequency distribution according to age

Age		Frequency	Percent
Valid	**<=20 Yrs**	7	7
	21-30 Yrs	18	18
	31-40 Yrs	39	39
	41-50 Yrs	36	36
	Total	100	100

Table 2: Gender wise distribution

Sex	Frequency	Percent	Mean Age	Std. Deviation (Age)	t-value	p-value
Male	30	30	35.80	9.66	0.83	0.41
Female	70	70	37.41	8.60		
Total	100	100				

RESULTS

In our study, ninty-three percent patients out of 100 enrolled were in the age group of 21-50 years (mean age 36.93±8.92 years). Only 7% patients were below the age of 20 years. (Table 1)
In our study population out of 100 patients, 70 patients were female and 30 were male. The mean age of males was 35.80 years and that of females was 37.41 years. (Table 2)
we found an increase in heart rate from PEEP S_0 to S_5 and decrease in heart rate from S_5 to S_{15} in supine position. However, the heart rate was found to be in continuous increasing pattern from PEEP T_0 to T_{15} in Tredelenburg position. Highest value of heart rate was 80.65 beats per minute at T_{15} and lowest value at S_{15} was 74.71 beats per minute. These changes were not statistically significant except in T_5-T_{15} i.e. on increasing PEEP from 5 to 15 cms of H_2O in Trendelenburg position. (Table 3)
When we analyzed the hemodynamic parameter- blood pressure, both systolic and diastolic BP were found to decrease with increasing PEEP value in supine as well as Trendelenburg position except on increasing PEEP from 0 to 5 cms of H_2O in supine position. This decrease in blood pressure was found to be statistically significant. (Table 4)

Table 3: Hemodynamic Parameters; Heart Rate: Paired Overall Data

	Sex	N	Mean	Std. Deviation	t-value	p-value
Pair 1	**HRS_0**	100	76.03	10.27	-1.23	0.22
	HRS_5	100	76.50	10.37		
Pair 2	**HRS_5**	100	76.50	10.37	1.71	0.09
	HRS_{10}	100	75.88	10.82		
Pair 3	**HRS_{10}**	100	75.88	10.82	1.14	0.26
	HRS_{15}	100	74.71	14.98		
Pair 4	**HRT_0**	100	75.48	10.75	-0.48	0.63
	HRT_5	100	75.65	10.49		
Pair 5	**HRT_5**	100	75.65	10.49	-3.87	**0.00**
	HRT_{10}	100	77.62	11.15		
Pair 6	**HRT_{10}**	100	77.62	11.15	2.05	**0.04**
	HRT_{15}	100	80.65	10.11		

Table 4: Hemodynamic Parameters; Blood Pressure

		N	Mean	Std. Deviation	t-value	p-value
Pair 1	**SS_0**	100	129.50	12.98	0.09	0.93
	SS_5	100	129.37	15.93		
Pair 2	**SS_5**	100	129.37	15.93	10.01	**0.00**
	SS_{10}	100	121.96	12.84		
Pair 3	**SS_{10}**	100	121.96	12.84	5.58	**0.00**
	SS_{15}	100	119.78	11.66		
Pair 4	**ST_0**	100	115.87	11.08	6.44	**0.00**
	ST_5	100	113.34	10.93		
Pair 5	**ST_5**	100	113.34	10.93	8.48	**0.00**
	ST_{10}	100	109.99	10.68		
Pair 6	**ST_{10}**	100	109.99	10.68	6.39	**0.00**
	ST_{15}	100	106.84	10.25		
Pair 7	**DS_0**	100	79.36	6.48	2.79	**0.01**
	DS_5	100	77.64	7.41		
Pair 8	**DS_5**	100	77.64	7.41	4.11	**0.00**
	DS_{10}	100	74.68	5.96		
Pair 9	**DS_{10}**	100	74.68	5.96	2.94	**0.00**
	DS_{15}	100	73.24	6.44		
Pair 10	**DT_0**	100	71.03	5.56	3.78	**0.00**
	DT_5	100	69.25	6.12		
Pair 11	**DT_5**	100	69.25	6.12	3.29	**0.00**
	DT_{10}	100	67.92	5.45		
Pair 12	**DT_{10}**	100	67.92	5.45	3.13	**0.00**
	DT_{15}	100	66.48	6.15		

Table 5: Change in Transverse and Anteroposterior Diameters

	$IJVS_0$	$IJVS_5$	$IJVS_{10}$	$IJVS_{15}$	$IJVT_0$	$IJVT_5$	$IJVT_{10}$	$IJVT_{15}$
IJV Transverse Diameter	1.36	1.41	1.49	1.49	1.49	1.56	1.65	1.65
IJV AP Diameter	1.14	1.21	1.28	1.28	1.32	1.39	1.46	1.46

Table 6: Changes in Transverse Diameter

		Changes in Transverse Diameter			
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	**$IJVS_0$**	1.3583	100	0.476	0.048
	$IJVS_5$	1.4137	100	0.468	0.047
Pair 2	**$IJVS_0$**	1.3583	100	0.476	0.048
	$IJVS_{10}$	1.4903	100	0.461	0.046
Pair 3	**$IJVS_{10}$**	1.3583	100	0.476	0.048
	$IJVS_{15}$	1.4906	100	0.460	0.046
Pair 4	**$IJVT_0$**	1.4913	100	0.427	0.043
	$IJVT_5$	1.562	100	0.413	0.041
Pair 5	**$IJVT_0$**	1.4913	100	0.427	0.043
	$IJVT_{10}$	1.6472	100	0.402	0.040
Pair 6	**$IJVT_0$**	1.4913	100	0.427	0.043
	$IJVT_{15}$	1.6483	100	0.402	0.040

Table 7: Changes in AP Diameter

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	**$IJVS_0$**	1.1381	100	0.300	0.030
	$IJVS_5$	1.2076	100	0.300	0.030
Pair 2	**$IJVS_0$**	1.1381	100	0.300	0.030
	$IJVS_{10}$	1.2794	100	0.305	0.031
Pair 3	**$IJVS_{10}$**	1.1381	100	0.300	0.030
	$IJVS_{15}$	1.2797	100	0.305	0.031
Pair 4	**$IJVT_0$**	1.3234	100	0.386	0.039
	$IJVT_5$	1.3923	100	0.382	0.038
Pair 5	**$IJVT_0$**	1.3234	100	0.386	0.039
	$IJVT_{10}$	1.463	100	0.378	0.038
Pair 6	**$IJVT_0$**	1.3234	100	0.386	0.039
	$IJVT_{15}$	1.4635	100	0.378	0.038

In both supine position and Trendelenburg position transverse and anteroposterior diameter showed increase from baseline values with increase increasing PEEP upto 10 cms of H_2O. However, there was no increase on increasing PEEP from 10 to 15 cms of H_2O. All these changes were statistically significant. The changes in transverse diameter when compared with those in anteroposterior were similar. (Table 5-7)

We studied the cross sectional area in a population of 100 patients consisting of 70 females and 30 male in supine and trendelenburg position with PEEP values of 0, 5, 10 and 15 cms of H_2O. In our study we found that there was no statistically significant difference in the cross sectional area amongst male and female population (p value ≥ 0.05). (Table 8)

When we analyzed the cross sectional area in 10 different groups with different PEEP values (5, 10, 15 cms of H_2O) from the baseline 0 and also the cross sectional area with same PEEP value in supine and Trendelenburg position, we found that there was no statistically significant difference (p value ≥ 0.05) among male and female patients in all 10 different groups. (Table 9)

When we analyzed the percent change in cross sectional area in 10 different groups with different PEEP values (5, 10, 15 cms of H_2O) from the baseline PEEP 0 and also the cross sectional area with same PEEP value in supine and Trendelenburg position, we found that there was no statistically significant difference (p value ≥ 0.05) in change in cross sectional area among male and female patients in all 10 different groups. (Table 10)

Table 8: Change in CSA with reference to: Gender

	Sex	N	Mean	Std. Deviation	t-value	p-value
AreaS$_0$	**Male**	30	1.36	0.93	0.323	0.747
	Female	70	1.30	0.85		
AreaS$_5$	**Male**	30	1.47	0.92	0.223	0.824
	Female	70	1.43	0.84		
AreaS$_{10}$	**Male**	30	1.61	0.91	0.161	0.872
	Female	70	1.58	0.84		
AreaS$_{15}$	**Male**	30	1.62	0.91	0.164	0.87
	Female	70	1.58	0.83		
AreaT$_0$	**Male**	30	1.64	0.94	0.109	0.913
	Female	70	1.67	1.08		
AreaT$_5$	**Male**	30	1.80	0.93	0.091	0.927
	Female	70	1.82	1.06		
AreaT$_{10}$	**Male**	30	1.97	0.91	0.155	0.877
	Female	70	2.00	1.04		
AreaT$_{15}$	**Male**	30	1.97	0.91	0.147	0.884
	Female	70	2.00	1.04		

Table 9: Changes in CSA in male and female with various application of PEEP in Supine and Trendelenburg position

	Sex	N	Mean	Std. Deviation	t-value	p-value
AreaS$_{0\text{-}5}$	**Male**	30	0.11	0.07	1.183	0.24
	Female	70	0.13	0.07		
AreaS$_{0\text{-}10}$	**Male**	30	0.26	0.17	0.835	0.406
	Female	70	0.29	0.16		
AreaS$_{0\text{-}15}$	**Male**	30	0.26	0.17	0.816	0.417
	Female	70	0.29	0.16		
AreaS$_0$-T$_0$	**Male**	30	0.29	0.08	1.183	0.24
	Female	70	0.37	0.40		
AreaS$_5$-T$_5$	**Male**	30	0.33	0.09	0.867	0.388
	Female	70	0.39	0.39		
AreaS$_{10}$-T$_{10}$	**Male**	30	0.35	0.12	0.902	0.369
	Female	70	0.42	0.39		
AreaS$_{15}$-T$_{15}$	**Male**	30	0.35	0.12	0.881	0.38
	Female	70	0.42	0.39		
Area T$_5$-S$_0$	**Male**	30	0.44	0.109	0.266	0.791
	Female	70	0.52	0.381		
Area T$_{10}$-S$_0$	**Male**	30	0.61	0.158	0.289	0.773
	Female	70	0.70	0.380		
Area T$_{15}$–S$_0$	**Male**	30	0.61	0.157	0.238	0.812
	Female	70	0.70	0.380		

Table 10: Changes in CSA in male and female with same PEEP in Supine and Trendelenburg position

Percentage Change	Sex	N	Mean	Std. Deviation	t-value	p-value
% Area S_{0-5}	**Male**	30	9.88	7.04	1.182	0.24
	Female	70	11.72	7.17		
%Area S_{0-10}	**Male**	30	23.17	16.56	0.855	0.395
	Female	70	26.28	16.65		
%Area S_{0-15}	**Male**	30	23.26	16.72	0.852	0.397
	Female	70	26.36	16.61		
%Area S_0-T_0	**Male**	30	21.22	10.41	0.59	0.556
	Female	70	22.57	10.41		
%Area S_5-T_5	**Male**	30	24.83	13.15	0.186	0.853
	Female	70	24.32	12.15		
%Area S_{10}-T_{10}	**Male**	30	27.00	17.05	0.189	0.851
	Female	70	26.38	13.95		
%Area S_{15}-T_{15}	**Male**	30	27.17	16.93	0.233	0.817
	Female	70	26.41	13.94		
%Area T_5-S_0	**Male**	30	44.23	23.19	0.31	0.75
	Female	70	45.98	26.40		
%Area T_{10}-S_0	**Male**	30	60.70	28.63	0.38	0.70
	Female	70	63.35	33.06		
%Area T_{15} –S_0	**Male**	30	60.98	28.62	0.36	0.72
	Female	70	63.46	33.04		

When the paired- T test was applied to overall data in paired groups, the mean cross sectional area obtained in the supine and Trendelenburg position amongst different groups was found to increase with the applied PEEP value 5 and 10 cms of H_2O from the baseline 0, but it was found to be similar with applied PEEP value of 10 and 15 cms of H_2O i.e. 1.59 ± 0.87 and 1.99 ± 0.10 respectively. The maximum CSA was 1.99±1.00 was found at T_{10}. (Table 11)

On comparing CSA change of each PEEP value with baseline values we found that the mean cross sectional area in the supine and Trendelenburg position was found to increase the CSA for applied PEEP value 0 to 10 cms of H_2O and it was more than that for the PEEP value 0-5 cms of H_2O (0.28 ± 0.16 as compared to 0.12 ± 0.07 and 0.66 ± 0.15 as compared to 0.50 ± 0.08). CSA remained same for the applied PEEP value 0-10 and 0-15 cms of H_2O in both supine and Trendelenburg position (0.28 ± 0.16 and 0.66 ± 0.33). When we compared the CSA on same PEEP value in supine and Trendelenburg position value we found that, at PEEP value 10 cm H_2O, CSA was more in Trendelenburg position (T_{10}) (0.66 ± 0.33) than in supine position(S_0-S_{10}) (0.28 ± 0.16). All these changes were statistically significant. (Table 12)

In our study we found an increase in the percentage of CSA in supine position as well as in Trendelenburg position with applied PEEP of 5 and 10 cms of H_2O from the base line PEEP 0. The percentage increase in CSA in supine position was almost similar for applied PEEP of 10 and 15 cms of H_2O i.e. 25.34±16.60 and 25.42±16.62 respectively. Also the percentage increase in CSA in Trendelenburg position was almost similar for applied PEEP of 10 and 15 cms of H_2O i.e 62.03 ± 31.676 and 62.22 ± 31.656 respectively. Hence maximum statistically significant percentage change in CSA was at T_{10}-S_0 (62.03%). When we compared the change in CSA percentage wise on same PEEP value in supine and Trendelenburg position value, we found that cross section area was maximum for change from S10-T10. (Table 13)

Table 11: Different PEEP values: Paired t test overall data

Paired Samples Statistics					
		N	**Mean**	**Std. Deviation**	**Std. Error Mean**
Pair 1	**Area S_0**	100	1.32	0.87	0.09
	Area S_5	100	1.44	0.86	0.09
Pair 2	**Area S_5**	100	1.44	0.86	0.09
	Area S_{10}	100	1.59	0.85	0.09
Pair 3	**Area S_{10}**	100	1.59	0.85	0.09
	Area S_{15}	100	1.59	0.85	0.09
Pair 4	**Area T_0**	100	1.66	1.03	0.10
	Area T_5	100	1.81	1.02	0.10
Pair 5	**Area T_5**	100	1.81	1.02	0.10
	Area T_{10}	100	1.99	1.00	0.10
Pair 6	**Area T_{10}**	100	1.99	1.00	0.10
	Area T_{15}	100	1.99	1.00	0.10

Table 12: Changes in CSA in male and female with same PEEP in Supine and Trendelenburg position

		N	Mean	Std. Deviation	Std. Error Mean
Pair 1	**Area S_{0-5}**	100	0.12	0.07	0.01
	Area S_{0-10}	100	0.28	0.16	0.02
Pair 2	**Area S_{0-10}**	100	0.28	0.16	0.02
	Area S_{0-15}	100	0.28	0.16	0.02
Pair 3	**Area T_5-S_0**	100	0.50	0.325	0.033
	Area T_{10}-S_0	100	0.66	0.331	0.033
Pair 4	**Area T_{10}-S_0**	100	0.66	0.331	0.033
	Area T_{15}-S_0	100	0.66	0.331	0.033
Pair 5	**Area S_0-T_0**	100	0.35	0.18	0.02
	Area S_5-T_5	100	0.37	0.19	0.02
Pair 6	**Area S_{10}-T_{10}**	100	0.40	0.22	0.022
	Area S_{15}-T_{15}	100	0.40	0.22	0.022

Table 13: Changes in CSA in male and female with same PEEP in Supine and Trendelenburg position

Paired Samples Statistics					
		N	**Mean**	**Std. Deviation**	**Std. Error Mean**
Pair 1	**% Area S_{0-5}**	100	11.16	7.14	0.72
	% Area S_{0-10}	100	25.34	16.60	1.67
Pair 2	**% Area S_{0-10}**	100	25.34	16.60	1.67
	% Area S_{0-15}	100	25.42	16.62	1.67
Pair 3	**% Area T_5-S_0**	100	45.11	25.374	2.537
	% Area T_{10}-S_0	100	62.03	31.676	3.168
Pair 4	**% Area T_{10}-S_0**	100	62.03	31.676	3.168
	% Area T_{15}-S_0	100	62.22	31.656	3.166
Pair 5	**% Area S_0-T_0**	100	22.16	24.765	2.476
	% Area S_5-T_5	100	24.48	28.697	2.869
Pair 6	**% Area S_{10}-T_{10}**	100	26.57	31.328	3.132
	% Area S_{15}-T_{15}	100	26.64	30.597	3.059

DISCUSSION

Internal Jugular Vein is the most commonly catheterized vein to have central venous access in today medical practice.[2] Ultrasound may help increase the success rate of central venous line placement and decrease complications 95% patients. Approximately 18% of right internal jugular veins are <5 mm in diameter and therefore difficult to cannulate Because the success rate for central venous line placement correlates with the cross sectional area (CSA) of the vein, several maneuvers to increase the filling and thus the diameter of the vein can facilitate cannulation and reduce potential side effects.[6]

A number of ultrasound studies have been conducted to determine the CSA of the right internal jugular vein in response to various maneuvers, such as the Trendelenburg and reverse Trendelenburg tilt position with different tilt degrees, the simulated (with 20 cms of H_2O during mechanical ventilation) and non-simulated Valsalva maneuver, hepatic compression, humming a tone, carotid palpation, needle advancement, and several combinations of maneuvers. The purpose of this study was thus to determine the effectiveness of different PEEP levels, the Trendelenburg maneuver, and a combination of the two on the CSA of the right internal jugular vein assessed by ultrasound measurement as a surrogate for central line cannulation conditions.[6-10]

In our study we enrolled a total 100 patients with age 18-50 years (mean age 36.93±8.92) of ASA I and II, mainly comprising of elective surgical patients (cholecystectomy) under general anaesthesia with volume controlled mechanical ventilation with tidal volume 8-10 ml kg, respiratory rate 12 breath bpm, and I:E ratio 1:2.The aim of our study was to evaluate the changes in Cross-Sectional Area of Internal Jugular vein in Trendelenburg position and after application of Positive End-Expiratory Pressure in patients under general anaesthesia. We examined the CSA of right internal jugular vein by using ultrasound probe at the level of cricoid cartilage when the patient was supine with head rotated to left side. The transducer was placed with least possible pressure to avoid jugular compression. We first took baseline value in control condition (S_0) and then applied 7 different maneuvers in random order: (1) a PEEP of 5 cms of H_2O (S_5), (2) a PEEP of 10 cms of H_2O (S_{10}), (3) a PEEP of 15 cms of H_2O (4) after tilting down the operating table to a 10° angle in Trendelenburg position (T_0) with PEEP of 0 cms of H_2O, (5) after Trendelenburg position with a PEEP of 5 cms of H_2O (T_5), (6) after Trendelenburg position with a PEEP of 10 cms of H_2O (T_{10}), (7) after Trendelenburg position with a PEEP of 15 cms of H_2O (T_{15}). After each maneuvers, the control condition was instituted for 1 minute. The images of anteroposterior and transverse diameters were taken, and then CSA of right internal jugular vein was obtained 1 minute after instituting each maneuver.

In our study, we found an increase in heart rate from PEEP S_0 to S_5 and decrease in heart rate from S_5 to S_{15} in supine position. However, the heart rate was found to be in continuous increasing pattern from PEEP T_0 to T_{15} in Trendelenburg position. These changes were not statistically significant except in T_5-T_{15} i.e. on increasing PEEP from 5 to 15 cms of H_2O in Tredelenburg position.

When we analyzed blood pressure, both systolic and diastolic BP were found to decrease with increasing PEEP values in supine as well as Trendelenburg position except in PEEP S0 and S5 in supine position.. This decrease in blood pressure was found to be statistically significant (p value < 0.05), but in our patients no vasoactive medications were however, required.

Our observations for BP values exactly correlate with the well-established fact that BP falls when PEEP increases. The variations in heart rate must have been due to various compensatory reflexes which are activated when BP starts falling. They could maintain HR with increasing PEEP in supine position. However, reflex tachycardia i.e. increase in heart rate was seen when Trendelenburg position was added to increasing PEEP values (T_5-T_{15})

In the study by Hollenbeck et al, although no patients required vasoactive medications for arterial blood pressure fluctuations, there was decrease in mean arterial blood pressure of 9.9 mm Hg and a decrease in mean pulse pressure of 6.6 mm Hg after application of PEEP 10 cms of H_2O. These results were similar to our study.[4]

Our study haemodynamic parameters changes were also comparable to, Marcus et al, Lee et al, Mareata et al, Cho et al, Han et al studies who found similar changes in heart rate and blood pressure.[6,11-14]

In both, supine and Trendelenburg position, transverse and anteroposterior diameters showed increase from baseline values with increase increasing PEEP upto 10 cms of H_2O. However, there was no increase on increasing PEEP from 10 to 15 cms of H_2O. All these changes were statistically significant. The changes in transverse diameter when compared with those in anteroposterior were similar.

Changes in CSA obtained in the supine and 10^0 Trendelenburg position was found to increase with the applied PEEP value 5 and 10 cms of H_2O from the baseline 0, but it was found to be same with applied PEEP value of 10 and 15 cms of H_2O in both supine and 10^0 Trendelenburg position i.e. 1.59 ± 0.87 and 1.99 ± 0.10 respectively. We found increase in percentage of CSA for S_5, S_{10}, S_{15}, T_0, T_5, T_{10}, T_{15} to be 11.16%, 25.34%, 25.42%, 22.16%, 45.11%, 62.03%, 62.22% respectively in reference to the baseline S_0. Hence the maximum increase in percentage of CSA was found with PEEP of 10 cms of H_2O applied in 10^0 Trendelenburg position.

Thus CSA increases on application of PEEP 0 to 10 cms of H_2O only and showed no significant further increase from PEEP values 10 to 15 cms of H_2O in both supine and 10^0 Trendelenburg position. However, the increase in CSA was found to be greater when both PEEP and 10^0 Trendelenburg position were combined. This shows that addition of PEEP increases the CSA significantly upto PEEP of 10 cms of H_2O and addition of 10^0 Trendelenburg position further enhances this effect.

Therefore, CSA of RIJV increases with PEEP values above 5 cms of H_2O. However the change above PEEP of 10 cms of H_2O are not statistically significant in both supine and 10^0 Trendelenburg position. Moreover, the changes are most significant when PEEP of 10 cms of H_2O and 10^0 Trendelenburg position are combined. Higher values of PEEP beyond 15 cms of H_2O and more than 10^0 Trendelenburg tilt position, compromised the haemodynamics of the patients in our pilot studies. Hence these values were chosen. No patient suffered any haemodynamic compromise, nor required any vasoactive medications in our study. None of our patients suffered any complications. Moreover, a sample size of 100 patients justifies the high power of our study.

Hence it is recommended that ASA grade I and II patients, application of a PEEP of 10 cms of H_2O combined with 10^0 Trendelenburg tilt position helps in better localization of the RIJV, as well as may be useful in its cannulation by increasing the CSA without any major compromise in the haemodynamics of the patients under general anaesthesia.

CONCLUSION

CSA of RIJV increases with increasing PEEP upto 10 cms of H_2O, 10^0 Trendelenburg position and on combining both. Increasing PEEP upto 15 cms of H_2O gives no further advantage in both supine and 10^0 Trendelenburg position. Maximum value of CSA 1.99 cm^2 was obtained on applying PEEP of 10 cms H_2O and 10^0 Trendelenburg position without comprising the haemodynamic status of the patient. This finding can be useful for cannulation of RIJV in patient undergoing GA by increasing CSA of RIJV and avoiding complications without further comprising the haemodynamic status of the patient.

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