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Comparison Between Sevoflurane and Isoflurane Anesthesia in Off Pump Coronary Artery Bypass Grafting in Patients of COPD with Right and Left Ventricular Systolic Dysfunction

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Abstract: ***A total of 100 COPD patients having right and left ventricular systolic dysfunction underwent off pump CABG surgery were included in prospective, randomized, comparative, parallel group study with an aim to find out the effects of sevoflurane and isoflurane anaesthesia on changes in coronary sinus blood flow, right and left ventricular systolic function before and after off pump CABG. All the patients were randomly allocated into two groups to receive either sevoflurane or isoflurane 1 MAC for off pump CABG . ME four chamber, modified bi-caval view used before and after grafting for detection of coronary sinus diameter, coronary sinus blood flow (ml/min) and VTI in cm. LV and RV systolic functions measured by end diastolic volume (ml) and ejection fraction (%). RV systolic functions were assessed by TAPSE and RVEF (%). Demographic profile, preoperative CSD, CSA, CSBF, CSVTI , LVEDV , LVEF%, RVEF%, TAPSE between the groups were comparable. Postoperatively CSA area and CSBF showed insignificant difference in between two groups, whereas CSVTI were comparable between two groups; Changes in VTI was significant between pre and postoperative period both in case of between and within the groups. Postoperative RVEF% (p0 .560) and TAPSE (p 0.530) also showed no significant difference between the groups, but within the group the changes were significant. Postoperative LVEDV and LVEF% between the groups showed no significant difference (p 0.659; p 0.965) . CSBF, CSVTI, RVEF, TAPSE improved after CABG in both the groups along with more improvement in sevoflurane recipient COPD patients.***

Keywords: CABG. COPD. Sevoflurane, Isoflurane. CSBF, LVEF% RVEF%

1. Introduction

Very frequently patients with right ventricular (RV) systolic dysfunction along with severe left ventricular systolic dysfunction (LVSD) undergo coronary artery bypass grafting (CABG), having an increased risk for morbidity and mortality. [1]A previous study revealed that after completion of revascularization coronary sinus blood flow and velocity time integral increased significantly which correlate with adequacy of revascularization.[2] Patients with decreased LVEF% (<50) had an improvement in LV systolic function after CABG[3] whereas, patients with right ventricular systolic dysfunction may deteriorate from preoperative period.[4] Study showed that, increase concentration of sevoflurane to 2 MAC act as better bronchodilator to improve poor right ventricular dysfunction..[5]

Aims

To find out the effect of sevoflurane on changes in coronary sinus blood flow by coronary sinus velocity time integral (CSVTI) before and after off pump CABG surgery.

Objectives:

1) Changes in left ventricular end diastolic volume and ejection fraction before and after off pump CABG surgery within and between the two groups.
2) Changes in right ventricular ejection fraction before and after surgery, within and between the two groups.

2. Methods

After obtaining Institutional Ethical Committee clearance and informed consent from patients this prospective, comparative randomized trial was conducted at cardiac anesthesia department of NRS Medical College Kolkata, from February 2017-september 2018.

A total 100 consecutive patients of COPD (FEV1/FVC<70% and 50% < FEV1< 80% predicted) underwent CABG with left ventricular EF% between 40 and 55 were included in this study. Gr S (received Sevoflurane 1 MAC; n=50), and, Gr. I (received isoflurane 1 MAC; n=50). Patients with dilated coronary sinus diameter (>1 cm), left ventricular ejection fraction<40%, and contraindication to insert TEE probe were excluded.

All the patients were premeditated with inj. midazolam 0.05 mg/kg intravenously. Anesthesia was induced with inj.

fentanyl 5 mcg/kg and titrated doses of inj. etomidate patients were intubated with inj. vecuronium 0.1 mg/kg. Anaesthesia was maintained with inj. fentanyl, midazolam and vecuronium. along with 1 MAC Sevoflurane in Gr S and 1 MAC isoflurane in Gr. I. BIS was maintained between 40 to 55. In both the groups heart rate, mean arterial pressure, central venous pressure, cardiac output, systemic vascular resistance monitored continuously throughout the procedure.

A 5 MHz Biplane TEE probe (vivid E 90 TEE) was inserted after induction of anesthesia . Midesophageal modified four chamber (ME 4C) and/or modified bicaval view used for the demonstration of CS, which was aligned at an angle correction of <20°. Pulse wave doppler measurement was done 1 cm before the CS inflow into the right atrium. Diameter of CS taken in 2D mode. Average of 3 velocity time integral (VTI) of CS was noted in diastole. CSBF per beat was then calculated as CS VTI × cross-sectional area of CS. Coronary sinus blood flow measured before initiation of revascularization and after revascularization.

Ejection fraction measured by M mode tracing from transgastric short axis view just above the papillary muscle. For measurement of ejection fraction measured left ventricular internal diameter at end diastole and systole.For assessment of right ventricular systolic function measured tricuspid annular plane systolic excursion(TAPSE) before sternotomy and after chest closure[6] i.e. after completion of revascularisation. TAPSE measured in 2-dimensional M-mode echocardiograms from the midoesophageal 4-chamber view, positioning the cursor on the lateral tricuspid annulus near the free RV wall and aligning it as close as possible to the apex of the heart. All patients data recorded into individual case record form and were compiled for future analysis.

Statistical analysis: All patient data were entered into Microsoft excel spread sheet. Statistical Analysis was performed with help of Epi Info (TM) 7.2.2.2.1 which is a trademark of the Centers for Disease Control and Prevention (CDC). Chi-square (χ^2) test was used to test the association between different study variables. Corrected χ^2 test was used in case of any one of cell frequency was found less than 5 in the bivariate frequency distribution. Test of proportion (Z-test) was used to test the significant difference between two proportions. t-test was used to test the significant difference between means. $p<0.05$ was considered statistically significant.

3. Results

Distribution of patients in the two groups were in the ratio of 1:1. with comparable mean age, weight, height and BMI.

Table 1 shows that, there was no significant difference in mean of all the pre-operative parameters of the patients of the two groups ($p>0.05$). Thus the patients of the two groups were matched for all the pre-operative.

Pre-operative values of the Parameters	Group-S (n=50) (mean±s.d.)	Group-I (n=50) (mean±s.d.)	t_{98}-value	p-value
Heart Rate	68.00±11.88	74.28±16.04	1.225	0.128 NS
Invasive blood pressure	75.94±9.65	77.24±9.58	0.676	0.501 NS
Central venous pressure	15.22±3.32	15.72±3.89	0.692	0.491 NS
Cardiac output	3.42±0.77	3.31±0.76	0.747	0.457 NS
Stroke volume	44.26±7.54	46.26±7.28	1.349	0.180 NS
Stroke volume resistance	1552.78±409.86	1609.06±390.00	0.703	0.483 NS
Coronary sinus diameter (cm)	0.48±0.08	0.54±0.13	1.665	0.119 NS
Coronary sinus area (cm^2)	0.20±0.10	0.26±0.15	1.218	0.122 NS
Coronary sinus blood flow (ml/sec)	1.35±0.61	1.81±1.00	1.788	0.116 NS
Velocity time integral (cm)	6.68±1.26	6.93±1.40	0.923	0.358 NS
LVEDV (ml)	81.01±25.51	80.77±22.70	0.998	0.321 NS
LVEF%	54.14±6.27	54.62±4.34	0.443	0.659 NS
RVEF%	49.81±6.97	49.05±5.95	0.806	0.422 NS
Tricuspid annular plane systolic excursion (cm)	1.21±0.13	1.19±0.12	1.223	0.127 NS

Table 2: Comparison of post-operative values of the parameters of the patients of the two groups

Post-operative values of the Parameters	Group-S (n=50) (Mean±S.D.)	Group-I (n=50) (Mean±S.D.)	t_{98}-value	p-value
Heart Rate	82.72±11.39	93.28±9.41	5.055	<0.001 S
Invasive blood pressure	62.46±2.79	64.78±8.01	1.98	0.044 S
Central venous pressure	10.88±2.61	12.92±3.85	3.1	0.003 S
Cardiac output	3.93±0.77	2.43±0.53	11.359	<0.001 S
Stroke volume	56.54±8.26	41.64±6.88	9.801	<0.001 S
Stroke volume resistance	1404.30±353.35	1327.02±339.50	1.115	0.268 NS
Coronary sinus diameter (cm)	0.58±0.10	0.57±0.13	0.452	0.653 NS
Coronary sinus area (cm^2)	0.27±0.09	0.27±0.14	0.255	0.799 NS
Coronary sinus blood flow (ml/se)	5.46±0.71	5.28±22.93	0.053	0.957 NS
Velocity time integral (cm)	8.88±2.13	7.68±1.38	3.351	<0.001 S

LVEDV (ml)	86.96±26.31	87.18±22.80	0.045	0.965 NS
LVEF%	57.68±6.64	57.30±4.33	0.343	0.732 NS
RVEF%	55.16±6.15	54.45±5.14	0.585	0.560 NS
TAPSE	1.78±0.15	1.72±0.11	0.63	0.530 NS

Table 2 shows that, there were significant differences in mean post-operative Heart Rate, Invasive blood pressure, Central venous pressure, Cardiac output, Stroke volume and Velocity time integral of the patients of the two groups ($p<0.01$)

4. Discussion

Nagraja[2] and co-workers estimated coronary sinus blood flow for the adequacy of revascularization after off-pump CABG and showed that, VTI after LAD revascularization increased from 8.93 ± 4.29 to 11.96 ± 5.68 ($P \leq 0.0001$) and after OM revascularization, it increased from 11 ± 5.53 to 12.09 ± 5.43 ($P = 0.002$) with no statistically significant change in CS diameter. Ng DW [7] and co-workers showed that, significant increase in CS VTI from 10.6 ± 1.93 to 13.4 ± 2.3 ($P = 0.01$) with no significant change in CS diameter. Toyota and co-workers also detected that, coronary sinus blood flow increased from 58.1±14.9 to 90.7±50.2 after revascularisation.[8]

In the present study coronary sinus VTI increased from 6.68±1.26to 8.88±2.13 after revascularisation in sevoflurane group and coronary sinus VTI increased from 6.93±1.40 to 7.68±1.38 in the isoflurane group. Both in S & I group coronary sinus blood flow increased from 1.35±0.61 to 5.46±0.71 & 1.81±1.00 to 5.28±22.93. Coronary sinus diameter in both the group increased from 48±.08 to 0.58±0.10 & 0.54±.13 to 0.57±.13 which was statistically significant.

Akazawa and coworkers[9] evaluated effects of sevoflurane on cardiovascular dynamics, coronary circulation and myocardial metabolism in dogs and revealed that, CSBF was significantly decreased at 2.5% sevoflurane and CVR was significantly decreased at 5% sevoflurane. The ratio of CSBF to CO (CSBF/CO) showed a tendency to increase as sevoflurane concentrations were increased.

In the present study CSBF increased from 1.35±0.61 to 5.46±0.71 & 1.81±1.00 to 5.28±22.93 in sevoflurane and isoflurane group respectively. Changes in CSBF between the two groups showed insignificant difference but coronary sinus VTI showed significant difference. More over within both the groups pre and postoperative changes in VTI showed significant difference with in the groups.

Koene and coworkers[3] evaluated that patient with pre-operative LVEF <50% had an improvement in LV systolic function whereas those with normal pre-operative LVEF had a decline in LV systolic function after CABG. Gentry-Smetana S[10] and co-workers found that there is reduction of left ventricular function at lower concentrations in sevoflurane group compared to isoflurane anaesthesia. At concentrations of 2% and greater, sevoflurane significantly reduced cardiac output, ejection fraction, fractional shortening which was different from this study and increased end-diastolic and end-systolic volumes but isoflurane-induced reduction of left ventricular function was much less in magnitude when compared with sevoflurane.

Present study shows that, left ventricular end diastolic volume increase after revascularisation in both sevoflurane and isoflurane anesthesia ,which was similar to Koene and Gentry-Smetana S and coworkers.

Preoperative LVE DV (p= 0.321) and LVEF% (p= 0.732) between the groups; postoperative period LVEDV (p=0.659) and LVEF% (p= 0.965) between the groups showed no significant difference.

Zanobini and co-workers studied on postoperative echocardiographic reduction of Right Ventricular Function. They stated that conventional sternotomy found a significant decrease in TAPSE (preop. 25.8 ± 5.2 mm; post op. 15.2 ± 3.1 mm; $p < 0.0001$) but right anterolateral thoracotomy showed a less marked reduction of TAPSE (preop. 23.5 ± 3.4 mm; postop. 22.2 ± 4.1 mm; $p = 0.06$), reduction of 3D RVEF% from 58.2 ± 7.2 to 55.4 ± 5.4 which also statistically significant. In present study both S & I group increase in TAPSE from 1.21±.13 to 1.78±0.15 ,1.19±0.12 to 1.72±.11 after closure of chest in CABG which was different from previous study and it was statistically significant(p=<.001) and increase of RVEF% from 49.81±6.97 to 55.16±6.15 ,49.05±5.95 to 54.45±5.14 it was also statistically significant(p=<.001) which was different from previous study. With sevoflurane anaesthesia there is more increase in TAPSE & RVEF% than isoflurane anaesthesia.

5. Conclusion

Sevoflurane has beneficial effect in improving coronary sinus flow and right ventricular function in COPD patient after CABG.

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