Study on the Effect of Total Intravenous Anesthesia (TIVA) on the Post-operative Respiratory Performance Regarding Early Extubation after Coronary Artery Bypass Graft (CABG) Surgery

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Summary:

The outcome of anaesthesia in coronary artery surgery depends partly on the duration of invasive manipulations including endotracheal intubation. It is ideal to avoid prolonged mechanical ventilation and attempt early extubation. Depressant effect of some anaesthetic agents and narcotics makes it a common practice to ventilate the patients of coronary artery bypass graft (CABG) surgery overnight resulting in unsatisfactory respiratory and haemo-dynamic performance. This study was aimed at overcoming the effects of prolonged mechanical ventilation after CABG surgery by using Total Intravenous Anaesthesia (TIVA) and by extubating the patient early to achieve a better post-operative respiratory cardiovascular performance.

The study was conducted prospectively on 40 patients between 40 to 60 years, divided into two groups of 20 patients each. Gr.-A received infusions of Propofol 2-6 mg/kg/hr, Fentanyl 0.5-1.25 mg/kg/hr and Pancuronium bromide 0.01mg/kg. Postoperatively Propofol was continued in infusion for one hour while Inj. Diclofenac sodium was used as an analgesic.

Patients in group B received a typical conventional anaesthesia and were ventilated electively till next morning.

The study showed that in CABG surgery, TIVA produces non-significant depression of post-operative respiratory performance which helps in early extubation compared to those receiving conventional anaesthesia and electively ventilated overnight.

*Key words**: TIVA, CABG, Early extubation*[1]

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Introduction:

The outcome of Cardiac surgery and anaesthesia depends on fast tracking which means early tracheal extubation, shorter stay in intensive care unit and minimization of complications [1].

Many randomized trials have found that early tracheal extubation can safely be achieved and may reduce the ICU stay measured by 'time to tracheal extubation' and a variety of haemo-dynamic endpoints [1-2]. However, some anaesthetic interventions may influence the outcome of cardiac surgery [3]. In the past, anaesthesia for CABG surgery was based on high dose opioids for haemodynamic stability which led to prolonged post operative mechanical ventilation. This practice has been questioned [4-5].

TIVA (Total Intravenous Anaesthesia) has been defined as 'a combination of hypnotic agent, short acting analgesic drug and muscle relaxant, excluding simultaneous administration of any inhaled agent'[6]. The development of new hypnotic and analgesic drugs has renewed interest in TIVA [7]. It enables the anesthesiologist to obtain a specific desired effect within a specific time frame. But there is considerable pharmacokinetic and pharmacodynamic variability even in matched patient populations[7].

TIVA is a standard procedure for day case surgery and other operations for shorter duration and to provide better haemodynamic stability and less neuro-humoral stress response to surgery,[8-9]. Some study concludes that

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TIVA represents an acceptable anaesthetic regimen for cardiac anaesthesia [10].

In cardiac anaesthesia it is a common practice to ventilate the patient mechanically overnight after CABG surgery to overcome the depressant effects of anaesthetic agents used intra-operatively. In this study, short acting analgesic (fentanyl) and anaesthetic agent (propofol) were used. Here, this regimen was applied to expedite early extubation without affecting the haemodynamics, pulmonary function, and other outcomes.

Materials and Methods:

In this prospective study, 40 patients between 40 to 70 years were divided into two groups of twenty patients each allocated by random selection of sealed envelope method. Group A was selected for TIVA by propofol, fentanyl and pancuronium bromide combination and group B received traditional balanced general anaesthesia (BGA)

for CABG surgery. Patients included in the study were of ASA grade I and II, ejection fraction 45% or above (Left ventricular function moderate to good.), and one/ two risk factors with Ischemic heart disease were allowed- e.g. - Diabetes Mellitus and/ or Hypertension. Exclusion criteria are detailed in Table- 1.

Both the groups were pre-medicated with oral midazolam 7.5 mg.

Group A patients were induced with propofol 1 to 2.5 mg/kg; Fentanyl 1-2 μg/kg and intubation was facilitated with pancuronium bromide 0.08 to 0.15 mg/ kg. Anaesthesia was continued with propofol infusion 2-6 mg/kg/hr, fentanyl: 0.5-1.25 g/kg/hr and pancuronium 0.04 mg/ kg followed by 0.01 mg/kg at 20-40 min. interval. Before transferring to the ICU, only propofol was continued and Inj. Diclofenac sodium 75 mg was given intramuscularly. Injection Pethidine was used as rescue analgesic.

Sleep was induced in Group B patients with thiopentone sodium 3-6 mg/kg; midazolam 0.1-0.4mg/kg; and morphine 0.01-0.5 mg/kg (not > 30mg) and intubation was facilitated by pancuronium (0.08 to 0.15 mg/ kg). Maintenance was done with nitrous oxide, halothane and intravenous morphine and pancuronium intermittently. Post-operative analgesia was maintained by inj. Morphine and followed by 75mg intramuscular diclofenac sodium. Patients were extubated the next morning.

Postoperative mechanical ventilation: Group patients were ventilated until they met the preset criteria for extubation, while those in group B were electively ventilated till next morning.

Rescue management for pain: Since we have deviated from usual analgesic therapy, it was not unexpected for some patient to have pain in the postoperative pain. If the patient complained of pain and found to have a score of more than 7 out of 10 VAS score, one would received injection pethidine 1.5 mg/kg intramuscularly. Such patients would also have dropped from the study.

Different intra operative data were collected in both the groups at 30 minutes interval which included pulse rate, intra-arterial blood pressure (IABP), pulse oxymetry (SPO2), electrocardiography (ECG), end tidal carbon-dioxide (ETCO2), central venous pressure (CVP), arterial blood gas (ABG), (PaO2, PaCO2) etc; were noted for further analysis

In group- A- in the post-operative period in the ICU, the propofol infusion was continued atat a rate of $\leq$ 2 mg/kg/hr for 1 hour and then gradually switched off after 2 hours approximately. Group- B patient received morphine 3 mg IV bolus and PCB 2 mg intermittently. They were ventilated mechanically to maintain PaCO2 between 35-40 mm of Hg and PaO2 > 90 mm of Hg. with FIO2 $\leq$ 45%. Patients were extubated when they fulfilled the extubation criteria. The time for extubation since the end of surgery was noted in both the groups. Injection diclofenac sodium 75mg was administered one hour before extubation and rescue analgesic was repeated at twelve hours interval.

Patients who did not meet the criteria for extubation (Table : 5) were excluded from the trial. Reversal of neuro-muscular blockade was done with neostigmine 2.5 mg with atropine 1.2 mg given intravenously.

After extubation, patients were monitored on an hourly basis for the next 3 hours. In addition, post-extubation data of respiratory parameters respiratory

rate, tidal volume, SPO2, ETCO2, PaO2, PaCO2), haemodynamic parameters (pulse, blood pressure, ECG for any arrhythmia, CVP, blood loss through drains, urine output); neuromuscular parameters , pain-parameters (grading of pain by visual analogue scale-VAS) and lastly the recovery Score by Aldrete and Kroulik's method was recorded.

Results and Observation :

The mean difference of all haemodynamic parameters before induction were statistically insignificant ($p>0.05$) between two group. Table 2 shows that the patients in the two groups were well matched.

On arrival in the ICU, when all patients were on ventilator, had no difference in resp parameters (table 3). However, they differed significantly at 30, 60 and 90 minutes after the surgery.

The mean difference of pain at extubation and subsequent 3 follow–up in each hour were statistically significant ($p<0.05$) between two groups. The mean difference of all neuro muscular parameters were statistically significant ($p<0.05$) between two groups (Table iii), except requirement of reintubation. Similarly mean recovery score of all follow-up were statistically significant ($p<0.05$) (Figure I).

Table-I

Exclusion criteria

Sl.	Criteria
1	Patient refusal
2	History of previous CABG surgery or heart valve surgery
3	Documented myocardial infraction within the previous six weeks
4	Overt congestive heart failure
5	Known history of respiratory illness like obstructive or restrictive lung disease or smoking
6	Known history of renal dysfunction with a creatinine level of > 150 mmol/1
7	Known history of seizure
8	History of allergy to propofol or its constituents
9	Renal dysfunction with a creatinine level of > 150 mmol/1
10	Anticipated ECC time (extra corporeal circulation time)- if prolonged & more than 4 hours and anticipated cross-clamp time- if more than 120 minutes

Table-II

Patient demography between groups.

Variables	TIVA (n=20)		Traditional (n=20)t value		t	Df	p value
	Mean±SEM	Range (min, max)	Mean± SEM	Range (min, max)			
Age	57.7±1.9	42 72	55.1±1.9	42 72	.962	38	0.342
Height	159.8±1.4	151 -170	151±1.7	150 173	.296	38	0.769
Ejection Fraction	55.3±1.1	48 62	55.7±1.3	51	60 -.238	38	0.813
Body surface area	1.7± .02	1.6 1.8	1.6± .03	1.4 1.9	1.34	38	0.189
Body weight	56.0± 1.1	53 60	57.2± 1.3	50 65	1.682	38	0.101

P value considered significant $p<0.05$

Table-III

Comparison of respiratory parameters between TIVA and Traditional group at arrival in ICU. (Patient in ventilator)

Parameters	TIVA(n=20)			Traditional (n=20)			t		P
	Mean±SEM	Min	Max	Mean±SEM	Min	Max	value	df	value
Respiratory rate	14±0.3	12	16	15±0.5	13	17	-1.98	38	0.123
Tidal volume	547.5±11.7	450	600	545.5±12.3	450	600	-1.38	38	0.176
SPO_2	99.6±0.3	98	100	100.0±0.2	98	100	1.85	38	0.102
$ETCO_2$	35.7±0.5	36	39	37.0±0.8	27	39	-1.39	38	0.171
PaO_2	345.9±19.9	227	500	327.2±9.6	312	452	0.85	38	0.402
$PaCO_2$	36.6±0.8	29	41	38.1±1.1	25	41	-1.13	38	0.265

P value considered significant p<0.05

Table-IV

Comparison of recovery score between TIVA and Traditional group.

	TIVA (n=20)		Traditional (n=20)		t value	df	p value
	Mean±SEM	Range (min, max)	Mean± SEM	Range (min, max)			
1 hour after	8.5±0.3	8 9	7.5±0.2	7 8	6.650	38	0.001
2 hours after	9.5±0.2	9 10	8.5±0.3	8 9	2.570	38	0.014
3 hours after	9.8±0.1	9 10	8.5±0.3	8 9	2.570	38	0.014

P value considered significant p<0.05
The above table show the mean difference of all follow-up were statistically significant (p<0.05) in unpaired t-test.

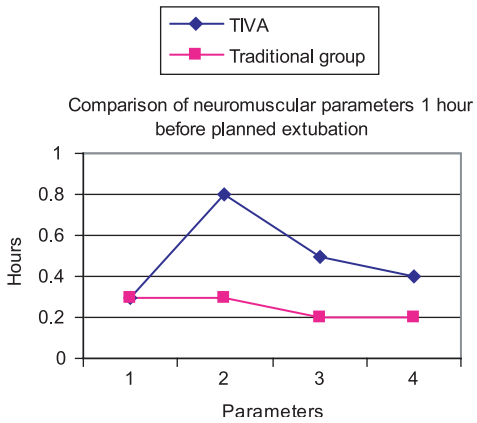

Fig.-1: *Comparison of neuro muscular parameters between TIVA and Traditional group 1 hours before planned extubation*

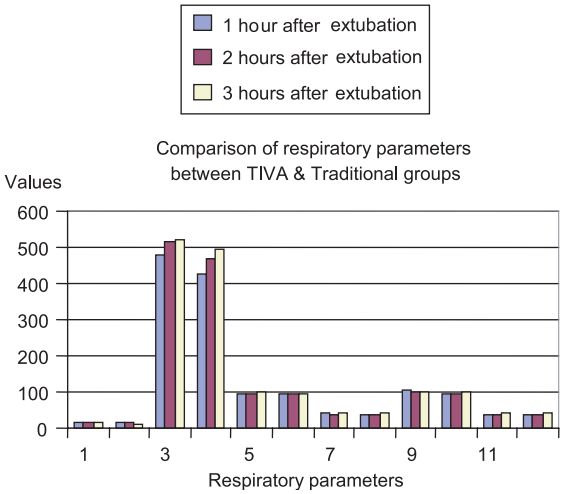

Fig.-2: *Comparison of respiratory parameters between TIVA and Traditional group*

Table-V

Extubation criteria

Parameters	Subclass	Extubation time	
Eye opening	1. Spontaneously	1. yes	1. Early extubation
	2. On command	2. yes	2. Delayed extubation
Muscle power	1. Hand grip	1. Strong- yes	1. Early extubation
	2. Leg raising	2. 15 seconds- yes	2. Early extubation
	3. Head lift	3. 5 sec - yes	3. Delayed extubation
TOF (Train of four) in Neuromuscular monitor	1. 75% of total muscle	1. yes	1. Early extubation
	2. 50% of total muscle	2. yes	2. Delayed extubation
Respiratory	1. Rate- 10-12/min	1. yes	1. Early extubation
	2. Tidal volume- 8-10 ml/kg	2. yes	2. Early extubation
	3. PaO2 >95mmhg in FIO2 60%	3. yes	3. Early extubation
Haemodynamic	1. Stable without inotrop support	1. yes	1. Early extubation
	2. Stable with inotrop support	2. yes	2. Early extubation
	3. Any mechanical device (IABP)	3. yes	3. Early extubation
	4. No new ECG change or myocardial infarction (ST segment > 2mm or T wave inversion in lead II).	4. yes	4. Early extubation
Pain	1. No pain	1. yes	1. Early extubaton
	2. Minimal pain	2. yes	2. Delayed extubation
Bleeding from chest drain	1. Minimal bleeding (< 50 ml/hr)	1. yes	1. Early extubation
	2. Greater blood loss (> 50ml/hr)	2. yes	2. Delayed extubation

Discussion:

Untill recent past , the traditional anaesthetic regimen for cardiac surgery was based on high dose opioids to afford a stable and safer recovery from surgery. But this has been challenged in favour of fast track anaesthesia to cut down the overall complications related to profound analgesia under elective postoperative ventilation for long hours.

The present study, based on this philosophy used short acting intravenous anaesthetic agent followed by a brief period of mechanical ventilation along with rapid emergence to full consciousness within very few hours of stopping anaesthetic drug.

At present what is commonly known as “fast track cardiac anaesthesia” (FTCA) which comprises early tracheal extubation to decrease length of intensive care unit stay, [11].

This randomised prospective study was carried out to see post-operative respiratory performance to help early extubation, early ambulation and to reduce length of stay in the post cardiac surgical ICU.

In a Turkish study, fast track protocol that is early extubation protocol under TIVA in patients older than 65 years was found suitable. In this study mean age of patients in both group was below 65 years but it is relatively higher in TIVA group, which showed better outcome [14].

Patients in both groups of our study were well matched and there were no significant difference in patient demography. No difference was observed in the respiratory parameters when they arrived in the ICU, except for respiratory rate which was higher in the traditional group.

The mean difference of all respiratory parameters 1 hour after arrival in ICU were statistically not significant ($p>0.05$).Similar significant results were also found in respiratory and haemodynamic parameters after 2 hours arrival in ICU.

In a study the influence of cardiopulmonary bypass (CPB) on respiratory performance was analyzed and proven that atelectasis lowers the partial oxygen tension in the arterial blood[15].

The mean difference of all respiratory parameter 1 hour after extubation were statistically significant ($p<0.05$) except SPO_2 and $PaCO_2$, which were insignificant and 2 hours and 3 hours after extubation were statistically significant ($p<0.05$) except $ETCO_2$ and $PaCO_2$, which were also insignificant.

Bedford RF and Wollman H found in their study that the respiratory rate was always higher postoperatively in patients who received halothane for coronary artery bypass disease, which closely agrees with the present study[16].

Fayez MK et al 2004 showed diclofenac alone or with paracetamol had a significant opioid–sparing effect after CABG producing rapid extubation and better oxygenation[17].

In an Indian study in 2009 , it was found that Rectal diclofenac suppository with tramadol provides adequate pain relief after cardiac surgery, and also reduces tramadol consumption and side effects commonly associated with tramadol [20].

All the neuro muscular parameters were significantly ($p<0.05$) higher in traditional group except requirement of reintubation. In the fast track setting, reversal of neuromuscular block should be done before weaning from mechanical ventilator[12]. Some author have found the pharmacokinetic profile of propofol favours earlier recovery from anaesthesia and sedation and thus earlier extubation[18-19]. In the present study the recovery score after 1, 2 and 3 hours were significantly ($p<0.05$) higher in TIVA group, which indicate that the mental function regain faster & titrated dose of muscle relaxant help recover neuromuscular function earlier [13].

The usefulness of TIVA on postoperative respiratory performance was analyzed in the present study. However efficiency of TIVA concerning cost effectiveness and complications- i.e. morbidity, mortality in distant future could not be verified in this small scale study. Though done on a small scale Bangladeshi population in a Bangladeshi setup (which in many ways are deficient) our study validates the findings of several studies done earlier in different centres.

Conclusion:

Present study suggests that CABG surgery under TIVA has an edge over traditional technique and results in marginally better respiratory performance after extubation than in anaesthesia with overnight mechanical ventilation on top of a stable haemodynamics with early neuromuscular recovery, early ambulation of the patient and shorter stay in the ICU. This study supports the concept of fast track anaesthesia for CABG under TIVA in our setup with favourable outcome.

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