Experience with Ross Basket Device for Single Right Atrial Venous Cannulation in Coronary Artery Bypass Graft Surgery

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ABSTRACT

Objective — *To describe the experience of using single right atrial venous cannulation using Ross basket for cardiopulmonary bypass (CPB) during coronary artery bypass graft (CABG) surgery.*

Study design — *Descriptive case series.*

Place & Duration of study — *Department of Cardiac Surgery, Karachi Institute of Heart Diseases and Cardiac Care Centre Karachi, from March 2009 to December 2011.*

Methodology — *A total of 450 CABG surgeries were undertaken with Ross basket single right atrial venous cannulation. Patient's demographic data, clinical status and outcome variables (conversion to dual-stage venous cannulation, cross-clamp time, CPB time, length of hospital stay) were retrospectively gathered. Continuous variables were reported as the mean ± standard deviation (SD) and categorical variables were reported as percentages. Statistical analysis was done by using SPSS version 17.*

Results — *A total of 450 CABG were performed during the study period. Mean age of the patients was 55.07 ± 9.8 year. There were 364 (80 %) males in this series. Ross basket device was successfully used in total 447 cases. The mean EF was 48.2 ± 11.2%, mean aortic cross-clamp time was 58.5 ± 12.8 minutes and the mean CPB time was 118.8 ± 25.8 minutes. Only 9 (2%) cases were reopened for bleeding. Post operative length of stay at hospital was 5.9 ± 1.6 days.*

Conclusions — *Ross basket is a safe, convenient, cheap and effective reusable alternative to dual stage venous cannula. It can be used in more than 95 percent cases undergoing CABG surgery, without any disadvantage or additional risk.*

Key words — *Cardiopulmonary bypass, Ross basket, Venous cannulation.*

INTRODUCTION:

Coronary artery bypass graft surgery has been used over the years for the treatment of coronary atherosclerotic disease (CAD).[1,2] Heart-lung machine along with membrane oxygenator has been used for artificial circulation and ventilation during the bypass surgery.[3] Cardiopulmonary bypass is established through arterial and venous cannulation. Through venous cannula deoxygenated blood from right side of the heart is received into the venous reservoir, gets oxygenated and then returned back to arterial circulation through aortic cannula.[4]

Venous cannulae are usually made of a flexible plastic, which may be stiffened against kinking by wire reinforcement. Cannula tips are straight or angled and constructed of thin, rigid plastic or metal, for optimal inner diameter to outer diameter ratio. Appropriate size of the cannula is determined by patient size, anticipated flow rate, and an index of catheter flow characteristics and resistance (provided by the manufacturer).[5] For an average adult with 60-cm negative siphon (gravity) pressure, a 30 French (F) cannula in the superior vena cava (SVC) and 34F in the inferior vena cava (IVC) or a single 42F in cavo-atrial cannula are needed. Venous cannulae are typically inserted through purse-string

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guarded incisions in the right atrial appendage, lateral atrial wall, or directly in the SVC and IVC.[6,7]

Usually, the venous connection for CPB is accomplished by inserting cannulae into the right atrium. There are three basic venous cannulation approaches in use: bicaval, in which separate cannulae are inserted into SVC and IVC; single atrial cannula and cavo-atrial ("two stage") cannula. The latter has a wider proximal section with holes that lie within the right atrium and a narrower extension with end and side holes that extends into the IVC.

Bicaval cannulae can be placed in each cava either directly (metal tipped) or via the right atrium. When bicaval cannulas are used, tapes are frequently placed around the cavae and passed through small tubes so they may be clinched down as tourniquets or snares around the cannula. This forces the patient's venous return to pass to the extracorporeal circuit, preventing any systemic venous blood from getting into the right heart and any air (if the right heart is opened) from getting into the venous lines. This is referred to as caval occlusion, or total CPB.[4,8] It provides better myocardial cooling, but can result in poor SVC or IVC drainage if either cannula gets malpositioned or blocked, causing venous congestion.

Cavo-atrial cannula ("two-stage") is typically introduced via the right atrial appendage. Its narrowed distal end is threaded into the IVC while the wider proximal portion has side holes designed to rest within the right atrium. It tends to be more stable and provide better drainage than a single cannula, but proper positioning is critical.[5] Two stage cannula provides enough venous return and access for most cardiac surgical procedures (coronary, aortic root, ascending aorta and arch). In some cases, insertion of the cannula tip into the inferior vena cava is difficult or impossible due to a variety of causes, such as a large Eustachian valve, a persistent Chiari network, or atrial adhesions. Forced positioning of the catheter is harmful and may lead to damage and hazardous bleeding complications in the right atrium, inferior vena cava, or both.[9]

Ross basket device is used for single venous cannulation. It has a large thimble shaped metal tip, perforated with several large holes, designed to sit in the right atrium. Single atrial cannulation has the advantage of being simple, faster, and less traumatic, with one less incision, and provides fairly good drainage of both the cavae and the right heart. It interferes least with caval return when off bypass. However, the quality of its drainage of the cavae and right heart is sensitive to positioning, especially with distortion of the heart (e.g., "circumflex position" when lifting the heart to make an anastomosis to posterior branches of the circumflex coronary arteries).[10]

The aim of this study was to report the experience of use of Ross basket atrial device, to drain the venous return during cardiopulmonary bypass, in a limited resource country as cost effective, convenient, less traumatic and equally safe alternative to dual stage disposable venous cannula.

METHODOLOGY:

A hospital based study was conducted between March 2009 to December 2011. During this period a total of 450 cases underwent CABG surgeries. For cardiopulmonary bypass, right atrial venous cannulation was achieved by using Ross Basket single venous cannula and arterial cannulation was performed at ascending aorta through aortic cannula.

Ross basket is a stainless steel fenestrated bulb like device, manufactured by Fannin (UK) Ltd., Pincents Kiln Industrial Estate, Calcot, Reading RG31 7SB, UK, (Instrument model number: GU 3738 Ê Dimensions: 29 mm, 1 1/8 inch length, Tubing size 1/2 inch), which was used to drain venous blood during cardiopulmonary bypass, from right atrium and then flow to the venous reservoir of oxygenator. From oxygenator, blood pumped back into the systemic arterial circulation through a cannula placed in the distal ascending aorta. Ross basket introduced into the right atrium through incision at the right atrial appendage and stabilized through purse-string sutures.[11] Ross basket was attached to the venous side of oxygenator tubing by threading it and fixing it directly to the patient side venous tube opening. Data on patient's demographics, clinical status, operative parameters and outcome variables (conversion to dual-stage venous cannulation, cross-clamp time, CPB time, length of hospital stay and in hospital complication rate) were retrospectively gathered from patients record files. Continuous variables were reported as the mean ± standard deviation and categorical variables were reported as percentages. Statistical analysis was performed by using Statistical Package for Social Sciences (SPSS) software version 17.

RESULTS:

A total of 450 patients underwent elective CABG surgery during the study period. The mean age of the study participants was 55.07 ± 9.8 year (range: 22-78 year) with 14 (3.1%) patients greater than 70 year of age. Males were more (n=364 - 80%)

than females (n=86 -20 %). Most of the study patients presented pre-operatively with significant risk factors of coronary heart disease; the most common were high blood pressure (n=247 - 54 %), diabetes mellitus (n=227 - 50 %) and renal impairment (serum creatinine level = 1.5 mg/dl) in 18 (4%) cases. Majority of CABG patients had pre-operatively diagnosis of three vessels disease (3VD), (n=329 -73%) followed by 2VD (n=86 - 19 %) and left main with 3VD (n=35 -8%). Pre operative mean left ventricular ejection fraction (EF) was 48.2 ± 11.2% (range: 20-70%).

Ross basket single venous cannulation was successfully performed in most CABG cases (n=447 -99%). In 3(1 %) cases (2 male and 1 female), Ross basket was not successful and were switched to dual stage right atrial venous cannulation. In majority of CABG, four grafts (n=114 - 57 %) were anastomosed. For all CABG cases mean aortic cross-clamp time was 58.5 ± 12.8 minutes (range 25-115 minutes) and the mean CPB time was 118.8 ± 25.8 minutes (range: 60-210 minutes). Details are given in table I. Out of all patients who had Ross basket cannulation (n=447), only 9 (2%) cases were reopened due to bleeding. Post CABG length of stay at hospital was 5.9 ± 1.6 days (range: 2-13 days).

DISCUSSION:

In present study males were dominant among patients who underwent CABG surgery, and had significant risk factors of coronary atherosclerotic disease like hypertension and diabetes mellitus. In all CABG cases, during cardiopulmonary bypass, Ross basket device ensured good venous return with empty decompressed heart which facilitated the anastomosis of coronary grafts especially when the heart was lifted while anastomosing the inferior and posterior vessels (posterior descending artery

Table I: Demographics and Clinical Status of the Study Patients

Characteristics	Frequency (n=450)	Percentage
Age in year (Mean + SD¶)	55.07 ± 9.8	(range:22-78)
> 70 years	14	3.1
Sex (Male)	364	80
Type of Coronary Disease		
Left Main with 3VD†	35	7.8
3VD	329	73.1
2VD	86	19.1
Ejection fraction percent (Mean + SD)	48.2 ± 11.2	(range:20-70%)
Diabetes mellitus	227	50.4
Hypertension	247	54.4
Deranged renal function (creatinine = 1.5 mg/dl)	18	4.0
No. of grafts anastomosed		
Two grafts	13	2.8
Three grafts	174	38.7
Four grafts	256	56.9
Five grafts	07	1.6
Bypass time (Mean +SD)	118.8 ± 25.8 min	(range: 60-210 min)
Cross clamp time (Mean +SD)	58.5 ± 8.5 min	(range: 25-115 min)
Reopened (n)	09	02
Length of hospital stay (Mean +SD)	5.9 ± 1.6 days	4.5 days (range: 2-13)
¶ Standard deviation † 3 vessel disease		

and obtuse marginal branch of circumflex artery). Although drainage of the IVC remains good with cavo-atrial cannulation also in the circumflex position, but the drainage of the SVC was often compromised.[12] The mean aortic cross-clamp and cardiopulmonary bypass times were 58.8 and 118.8 minutes respectively. This demonstrates that CABG with Ross basket can be accomplished within reasonable operating times. Previously a prospective study revealed that prolonged CPB times give rise to increase in gut permeability.[13] Moreover it has also been shown that inflammatory response was increased significantly with prolonged CPB times.[14]

In less than one percent of cases perioperative conversion from Ross basket to dual stage venous cannulation was needed. This failure was due to small size of right atrial appendage in two cases and the presence of atrial pacing lead in right atrium in one patient which did not allow the Ross basket to enter the right atrium and subsequently a dual stage venous cannula was used.

A single atrial cannula is as efficient in draining venous blood from the right side of the heart as two caval or a cavo-atrial cannula.[12] Double caval cannulation is not superior to single atrio-caval drainage as far as postoperative left and right heart performance, and prevention of supraventricular tachyarrhythmia are concerned. Single cannulation did not increase the risk of undue hemodilution or respiratory dysfunction.[15] Ross basket is currently used in financial resource limited setting particularly in developing countries, where operative cost is high for a common person. It can be reused after sterilization and hence save the cost of dual stage disposable venous cannula. Developed world utilizes other options (dual stage, bicaval, extra corporal) more frequently because they have no financial constrains.

The limitations of this includes its retrospective nature of analysis. There was lack of dual stage venous cannulation control group for appropriate comparison. In addition, no long term follow up on clinical status or post-operative complications were made and no long term echocardiographic or graft study measures were available.

CONCLUSIONS:

Ross basket is a safe, convenient, cost effective, less traumatic, and reusable alternative to disposable dual stage venous cannula. It can be used in cases undergoing CABG without any superadded risk. However when using Ross basket one should always have a dual stage venous cannula ready as an alternative backup of Ross basket failure.

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