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Haemodynamic Stability During Off-Pump Coronary Bypass Grafting: Apical Suction Vs. Deep Pericardial Suture

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Abstract: Off-pump coronary surgery is an established entity. Safe exposure of inferior and lateral wall vessels remains a challenge for complete revascularization. We compared deep pericardial stitches with apical suction to overcome this challenge. There were 16 patients in each group. Patients with only anterior wall disease were excluded. Heart rate, arterial blood pressure, central venous pressure, end tidal CO^2 and standard base excess were recorded. The observed parameters in both groups showed that heart in apical suction group performed better during inferior and lateral wall exposure. Requirement of noradrenaline was less. However both groups showed similar pattern of recovery once shifted to ICU. Apical suction is a better option for the exposure of inferior and lateral walls as compared to deep pericardial stitch, in order to achieve complete revascularisation on beating heart.

Key words: Off-Pump Cabg · Deep Pericardial Stays · Apical Suction · Cardiac Positioning

INTRODUCTION

With advances in the treatment of ishaemic heart disease, coronary bypass surgery remains a safe and superior form of treatment. Off-pump bypass surgery is a recent development in its safe dispensation [1-4]. It is of prime importance in this technique that the heart tolerates luxation and stabilization with good hemodynamics. Octopus 4.3 cardiac stabilizer (Medtronic, Minneapolis, MN, USA) and Starfish apical suction heart positioning device (Medtronic, Minneapolis, MN, USA) were designed to ensure that luxation was well-tolerated [5]. Availability of these stabilizers and heart positioning devices have made off-pump coronary artery bypass grafting (CABG) an integral part of cardiac surgery and complete revascularization on a beating heart has become possible [6, 7]. Experienced surgeons are applying this technique to an increasing proportion of their patients and are able to revascularize vessels in all coronary territories. We compared the hemodynamic effects of this system with the classic posterior pericardial stay suture procedure for heart position during Off-pump CABG surgery.

MATERIALS AND METHODS

Altogether 210 patients so far had coronary bypass surgery on beating heart in our institution. Routinely deep pericardial stay sutures were used to achieve exposure of lateral and inferior cardiac surfaces. In 16 recent cases apical suction device (AS group) was used to achieve the same exposure. These were compared with 16 most recently performed off-pump CABG cases where deep pericardial stays (DS group) were used for cardiac positioning. Patients who had grafts only on the anterior wall (LAD ±Diagonal) were excluded from this study.

In the DS group three stays were applied; 1st) just above the superior pulmonary vein, 2nd) between Inferior pulmonary vein and IVC, 3rd) next to IVC. Traction on first stay rotates the heart medially and brings to view left anterior descending and diagonal arteries. Traction on second and third stay lifts the cardiac apex up and also rotates the heart medially making posterior descending and oblique marginal arteries accessible. As for exposure of main right coronary artery; traction on third pericardial alone does the job. The deep pericardial suture technique was used for all anastomoses. The Octopus 4.3 heart

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stabilizer (Medtronic, Minneapolis, MN, USA) was used during the anastomoses in all patients. The Starfish apical suction heart positioning system (Medtronic, Minneapolis, MN, USA) was used to position the heart for lateral and inferior wall exposure in AS group.

Electrocardiogram was monitored continuously to detect myocardial ischemia, if any, from ST segment changes. Continuous heart rate (HR), central venous pressure (CVP), Peak systemic arterial pressure (SAP), end tidal CO2 were measured. Metabolic acidosis, if any, was recorded from half hourly blood gas analysis.

After administration of general anaesthesia, all patients underwent standard median sternotomy. Pericardiotomy was performed in an inverted "T" fashion. Sternal self retaining spreader was applied in reverse fashion(key at the cranial end) to accommodate starfish and Octopus devices simultaneously. Operating table was routinely rotated right and left wards and in Trendelenburg position to stabilize hemodynamics and achieve exposure of inferior and lateral coronary territories. This also helped in maintaining adequate right ventricular filling.

Sequence of anastomosis was determined from angiographic review, with the aim to displace the heart least and anastomose the least critical, or totally occluded vessel first. Complete revascularization was performed in all patients using arterial grafts (internal thoracic and radial arteries) and sephenous vein if needed. In our routine protocol, norepinephrine, boluses or infusions or both were administered with body position changes and gravity support to stabilize hemodynamics and maintain SAP > 130 mmHg. Before arteriotomy of recipient, in each group, hemodynamic parameters were measured and norepinephine doses were adjusted.

Data was recorded and analysed using SPSS 15 program.

RESULTS

Demography of DS and AS were compared (Table 1). Majority of patients in both groups (62.5%) had triple vessel disease and mild to moderate left ventricular dysfunction (Table 2). There was no operative mortality. No patient was converted to cardiopulmonary bypass. There were no ST segment changes recorded during or after the surgical procedure in both groups. All patients were shifted to ICU with minimal adrenaline support which in all cases was weaned within a couple of hours. Patients were allowed to wake up early and all patients were extubated within 3 hours of arrival in ICU.

Table 1: Demography of the groups

DS	AS	
Sex		
Males	11	11
Females	5	5
EF		
Normal	8	8
Moderate	8	7
High	Nil	1
Diabetes	4	6
Hypercholesteraemia	7	9
Type A personality	4	7
Family History	5	7
BP	6	8
Smoking	4	8

Table 2: Angiographic Profile

n =32	DS	AS	Cumulative Percentage
2 VD	4	2	18.8
3 VD	10	10	62.5
4 VD	2	4	18.8
LV Dysfunction			
Normal	2	1	9.4
Mild	8	5	40.6
Moderate	8	7	46.9
Severe	0	1	3.1

Table 3: Conduits Used

n=96	Deep Stay	Apical Suction
Sole LIMA	11	7
BIMA	5	8
Radial	4	5
BI-Radial	0	2
SV	25	14

LIMA, left internal mammary artery; BIMA, bilateral internal mammary arteries; SVG, sephenous vein;

Table 4:Vessels Involved

	Deep Stay	Apical Suction
LAD	16	16
Diagonal	1	7
OM 1	13	12
OM 2	2	1
RCA	4	4
PDA	9	10

A total of 96 coronary anastomoses were performed. Fifty seven arterial conduits were used (Table 3). LAD(Left Anterior Descending) was grafted in all case either with LIMA(Left Internal Mammary Artery) or RIMA(Right Internal Mammary Artery) {n=7}. Anterior wall vessels(LAD, Diagonal) were grafted in 40 instances; lateral wall vessels(OM1, OM2){Oblique Marginal} 28 and inferior wall vessels(RCA, PDA) {Right Coronary Artery, Posterior Descending Artery}27 times (Table 4).

Recorded parameters between the two groups showed significant difference while positioning the heart for inferior and lateral wall anastomosis). Hemodynamic conditions were stable in all patients at baseline (Table 5).

Table 5: Hemodynamic Variables

		Anterior Wall		Inferior Wall		Lateral wall	
	Base Line	DS	AS	DS	AS	DS	AS
Heart Rate	68	72	72	86	78	96	82
Systolic Pressure	150	145	155	130	148*	115	145*
CVP	4	4	4	9	7	11	6
End Tidal CO^2	42	40	42	48	44	52	44
Norepinephrine (ml/hr)	nil	0-2	0-2	5-12	2-5*	10-20	2-5*
SBE	0_-2	0_-2	0_-2	-4_-7	0_-2*	-5_9	0_-3*

SBE =standard base excess* p _ 0.001

There were no significant hemodynamic changes during anastomosis on the anterior wall. During vertical displacement of the heart for anastomosis on the inferior wall, there was a decrease in SAP by 18 _ 44% with a concomitant increase in CVP of 10 _ 18%, more pronounced in the DS group. During anastomosis on the lateral wall, there was more significant reduction in the indices, in both groups(Table 5).

The inotropic support was highest during anastomosis on the lateral wall (78.4% *v* 21.9% for anterior wall) in the DS group.

End tidal CO^2 and SBE(Standard Base Excess) remained close to baseline during cardiac maneuvering in AS group. Also requirement for isotonic crystalloid solutions or noradrenaline infusion, to maintain systemic blood pressure near baseline values were significantly low (Table 5).

DISCUSSION

Concerns regarding adverse effects of cardiopulmonary bypass have led to the current widespread application of off-pump techniques for CABG surgery. It was initially restricted to patients who were at high risk for cardiopulmonary bypass because of aortic atheromatous disease, advanced age, or severe systemic disease[8-10]. So far real success has been limited by the lack of an effective technique for successful grafting of the inferior and lateral coronary vessels. To facilitate exposure of the branches of circumflex artery and to overcome hemodynamic derangement during displacement of the heart, specialized surgical techniques, such as placement of deep pericardial sutures, patient positioning, pharmacologic manipulation, widely opening the right pleura and recently, application of a suction-based cardiac positioning device, had been suggested [11-14].

During off-pump surgery, hemodynamic monitoring is very important. Pulmonaryartery floatationcatheter and transesophageal echocardiography have been used, but not with accuracy (tricuspid and mitral valve regurgitation, arrhythmia, undetectable wall ischemia) [15-17].

We have relied only on indirect indices mentioned above to assess cardiac function. We could derive fair judgement of cardiac performance as as evident from the ionotropic requiremens and post operative recovery in ICU. Deep pericardial sutures before the introduction of suction device was uncomfortably used surgeons. This was evident from number of incomplete revascularisations and compromised graft patency of lateral wall in particular. Initial experiences with a heart stabilization device were limited to vessels on the anterior surface of the heart, which were easily bypassed with excellent stabilization. Lateral and posterior vessels pose greater technical challenges because hemodynamic tolerance to the cardiac displacement necessary for exposure is poor. The decrease in cardiac output during anastomoses on the posterior coronary arteries was greater in DS group, compared to AS group. Our results indicate that the differences between the two positioning methods were significant, more pronounced during Cx anastomosis. This was attributed to the fact that Cx anastomosis was performed on a rotated heart. Our observation is that vertical luxation is tolerated well compared to medial rotation for exposure of Cx branches. Furthermore, it is well known that the traction and mobilization necessary for Cx anastomosis are more distorting to heart anatomy.

Following the development and frequent use of apical suction device [18, 19], tolerance of the heart to luxation and access of lateral and inferior walls with harmodynamic stability became easy. Hence more and more complete revascularization with good medium and long term patency rates are being performed. However, these supports produce additional operative costs and the question of whether off-pump CABG still remains cost effective is unresolved. Fernández and Dzwonczyk have shown that apical suction can lead to myocardial ischaemia [20, 21] wehave not found any evidence to support there contention.

CONCLUSION

It was concluded that, the apical suction heart positioner was safe and useful in controlling hemodynamic stability during OPCAB, with superior results compared to the classic deep pericardial suture.

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