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Deep Pericardial Traction Suture versus Vacuum-Assisted Apical Suction to Expose the Posterior Wall of the Heart in Off-Pump Coronary Artery Bypass: A Prospective, Randomized Study

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ABSTRACT

Background: Displacement of the heart to expose the posterior vessels during off-pump coronary artery bypass (OPCAB) may cause hemodynamic instability. Deep pericardial traction suture (DPTS) and vacuum-assisted apical suction (VAS) with the Starfish positioning device help to provide good exposure without relevant hemodynamic changes. Our aim was to compare these two methods in patients undergoing multivessel OPCAB.

Methods: We prospectively randomized 20 patients undergoing multivessel OPCAB to the use of VAS or DPTS. The Octopus device was used in both groups to stabilize the target vessel. Hemodynamic parameters, including venous oxygen content (SvO_2), cardiac index (CI), central venous pressure (CVP), mean arterial pressure (MAP), pulmonary artery pressure (PAP), and pulmonary capillary wedge pressure (PCWP), were measured before grafting (baseline), after heart positioning, and during performance of peripheral anastomoses.

Results: Perioperative data for the two groups were similar. During exposure of the lateral wall, there were fewer hemodynamic changes in the DPTS group (increase in CVP) than in the VAS group (increases in CVP, PAP, and PCWP); the CVP was significantly higher in the DPTS group ($P < .05$). During exposure of the posterior wall, significant hemodynamic changes occurred only in the DPTS group (increase in PCWP). Values for all other parameters were similar, including anastomosis time, graft flow, postoperative myocardial enzymes, and inotropic support.

Conclusions: Heart positioning during OPCAB with either VAS or DPTS is a safe and effective maneuver for exposure of coronary arteries. In our study, the use of the VAS device produced less hemodynamic impairment during exposure of the lateral and posterior walls.

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INTRODUCTION

Coronary artery disease is still a leading cause of death in Western countries, and despite the advances in percutaneous coronary interventions, more than 400,000 coronary bypass operations are annually performed in the United States. The last decade has seen a continued increase in the percentage of coronary bypass operations performed without extracorporeal circulation, ie, off-pump coronary artery bypass (OPCAB).

The argument in favor of OPCAB surgery has been to avoid the well-documented adverse effects of cardiopulmonary bypass on end-organ function [Magee 2008]. The results of meta-analyses and the latest large randomized trial, however, indicate that OPCAB surgery has no obvious benefit with respect to short- and midterm outcomes [Shroyer 2009].

Moreover, the controversial issue of graft patency, complete revascularization, and long-term outcomes for OPCAB cases, compared with conventional coronary bypass surgery with cardiopulmonary bypass, then comes to the fore [Parolari 2005]. The critical point of OPCAB surgery seems to be the quality of the distal anastomosis and therefore the optimal exposure of the target vessels under tolerable hemodynamic conditions.

Although the anterior wall of the heart is easily accessible via a median sternotomy, the approach to the lateral and posterior walls is more difficult. Different techniques have been described to approach these areas under beating heart conditions. All modern techniques involve the enucleation of the heart, which lifts the apex of the heart upward and out of the pericardial sac. The deep pericardial traction suture (DPTS) technique is a modification of the operation first described by Ricci et al [2000]. It uses deep pericardial retraction sutures or the use of a stockinette sutured into the oblique sinus to displace the heart.

Alternatively, a vacuum-assisted apical suction (VAS) device can be used. This device holds the heart at its apex with vacuum pressure and positions it by the use of a flexible arm [Dullum 2000]. One of the most frequently used VAS devices is the Starfish Heart Positioner (Medtronic, Minneapolis, MN, USA).

The success of OPCAB surgery crucially depends on the quality of the exposure of the target vessels while the distal anastomosis is being performed. The necessary displacement of the heart could impair cardiac function and cause hemodynamic instability. The quality of the surgical technique used and the applied surgical tool can be assessed by the patient's hemodynamic stability during the distal anastomoses of the bypass grafts.

The aim of this study was to compare the DPTS technique and the VAS device for displacement of the heart with respect to intraoperative and postoperative parameters.

METHODS

The study was approved by the local ethics committee, and each patient gave informed consent. We enrolled 20 patients who were to undergo multivessel OPCAB surgery. These patients were randomly assigned preoperatively to the VAS group or to the DPTS group.

Anesthesiology Management

Isoflurane, midazolam, sufentanil, and pancuronium were used for anesthesia during all procedures. For intraoperative monitoring of myocardial ischemia, we used a combination of echocardiography lead II and lead V5. ST-segment deviation of less than –0.1 mV or greater than 0.2 mV were considered pathologic. Catheters were placed in a radial artery, the right internal jugular vein, and the pulmonary artery. The patient's temperature was maintained throughout the surgery by means of a heated water mattress and the warming of infusions.

The left and right ventricular preload was monitored via pulmonary artery catheter and transesophageal echocardiography. Our strategy was to maintain the preload in the optimal range, the mean arterial pressure (MAP) at >65 mm Hg, and the cardiac index (CI) at >2.5 L/min per m^2. When necessary, the preload was increased by applying the Trendelenburg position for volume redistribution, followed by infusion of hydroxyethyl starch (130/0.4) until cardiac function did not improve further by volume load. If these measures did not produce a MAP >65 mm Hg and a CI >2.5 L/min per m^2, we initiated pharmacologic support.

Catecholamines were administered as a continuous infusion. Low peripheral resistance was treated with norepinephrine, and low output in the presence of a sufficient volume load was treated by administering milrinone or epinephrine.

Surgical Procedure

A single surgeon performed all of the operations. The heart was exposed through a median sternotomy, and the pericardium was opened through a T-shaped incision and extensively separated from the diaphragm. Both pleural cavities were opened through a longitudinal incision. All patients received heparin (100 IU/kg) to achieve an activated coagulation time >250 seconds.

Grafts to all three main coronary arteries were performed in all patients. The procedure was as follows: a first anastomosis to either the left anterior descending coronary artery (LAD) or a diagonal branch (graft 1), a second anastomosis to the circumflex artery or a marginal branch (graft 2), and a last revascularization to the right coronary artery or an end branch of the right coronary artery (graft 3). The left internal thoracic artery was used as a graft to the LAD, and saphenous vein grafts were used for all other coronary arteries.

Table 1. Demographic Profiles of the 20 Patients Undergoing OPCAB Surgery*

Variable	Total (N = 20)	VAS (n = 10)	Suture (n = 10)	*P*
Female/male sex, n	4/16	2/8	2/8	1
NYHA functional class, n				.62
I	9	4	5	
II	8	5	3	
III	3	1	2	
No. of grafts per patient, n				.77
3	12	6	6	
4	5	2	3	
5	3	2	1	
Diabetes mellitus, n	7	2	5	.16
Hypertension, n	20	10	10	—
Recent myocardial infarction, n	3	2	1	.53
Prior PTCA, n	9	3	6	.18
Hyperlipidemia, n	15	7	8	.61
Obesity, n	9	5	4	.65
Age, y	66 9	63 8	69 9	.37
Ejection fraction, %	66 12	61 13	70 11	.28

*Age and ejection fraction data are presented as the mean SD. OPCAB indicates off-pump coronary artery bypass; VAS, vacuum-assisted apical suction; NYHA, heart failure classification of the New York Heart Association; PTCA, percutaneous coronary angioplasty.

The bypass to the anterior wall was performed without the use of a positioning device. For exposing the lateral and posterior walls (grafts 2 and 3), either the DPTS technique or a VAS device (the Starfish Heart Positioner) was used, depending on the preoperative assignment.

For the DPTS group, the heart was elevated with a heavy suture that was placed on the right side of the spine, halfway between the level of the right inferior pulmonary vein and that of the inferior vena cava. The suture is passed through a half-folded swab and snared down. Pulling on both limbs of the swab in a direction opposite to the target produced the appropriate exposure [Ricci 2000].

In the VAS group, the suction element of the Starfish positioner was applied on the apex of heart to elevate and rotate the left ventricle into the midline. The level of vacuum pressure needed to maintain capture of the heart varied between 200 and 250 mm Hg.

In both groups, a tissue stabilizer (Octopus; Medtronic) was used. No intracoronary shunt was inserted during performance of the distal anastomosis. After completion of the anastomosis, the heart was returned to the pericardial cavity,

Table 2. Anastomosis to Lateral Wall: Hemodynamic Parameters with the Vacuum-Assisted Apical Suction (VAS) Device or the Deep Pericardial Traction Suture (DPTS) Technique*

Variable/Group	T0	T1		T2	
			P		*P*
CI, L/min per m^2					
VAS	2.6 ± 0.6	2.3 ± 0.4	.90	2.3 ± 0.4	.90
DPTS	2.6 ± 0.6	1.9 ± 0.4	.18	2.2 ± 0.8	.91
CVP, mm Hg					
VAS	6 ± 4	**12 ± 5**	**.02**	**11 ± 4**	**.02**
DPTS	8 ± 3	**19 ± 5**	**.01**	**18 ± 6**	**.01**
MAP, mm Hg					
VAS	85 ± 17	75 ± 7	.22	76 ± 7	.46
DPTS	76 ± 7	83 ± 13	.6	82 ± 14	1
PAP, mm Hg					
VAS	21 ± 8	25 ± 9	1	24 ± 8	1
DPTS	20 ± 7	**31 ± 5**	**.01**	**31 ± 5**	**.01**
PCWP, mm Hg					
VAS	11 ± 17	16 ± 7	.50	15 ± 8	1
DPTS	9 ± 2	**21 ± 2**	**.01**	**21 ± 3**	**.01**
SVR, dyn s/cm^5					
VAS	1311 ± 568	1151 ± 387	1	1213 ± 378	1
DPTS	1065 ± 300	1500 ± 665	.62	1509 ± 648	.68
PVR, dyn s/cm^5					
VAS	171 ± 126	173 ± 101	1	158 ± 59	1
DPTS	155 ± 53	231 ± 141	.69	236 ± 92	.70
Norepinephine, µg/kg per min					
VAS	0.24 ± 0.22	0.08 ± 0.06	.07	0.07 ± 0.07	.16
DPTS	0.22 ± 0.36	0.05 ± 0.02	.26	0.07 ± 0.02	1
Milrinone, µg/kg per min					
VAS	0.04 ± 0.07	0.14 ± 0.18	1	0.34 ± 0.65	.24
DPTS	0 ± 0	0.08 ± 0.11	.35	0.05 ± 0.10	.89

*Data are presented as the mean SD. Statistically significant differences ($P < .05$) compared with T0 (baseline, 5-10 minutes after sternotomy) are highlighted in boldface. T1 indicates after displacement of the heart just before occlusion of the target vessel; T2, during performance of the distal anastomosis 5 minutes after occlusion of the target vessel; CI, cardiac index; CVP, central venous pressure; MAP, mean arterial pressure; PAP, pulmonary artery pressure; PCWP, pulmonary capillary wedge pressure; SVR, systemic vascular resistance; PVR, pulmonary vascular resistance.

and the proximal anastomosis with the aorta was performed. Distal coronary anastomoses were performed with a running 7-0 monofilament suture. Proximal anastomoses to the ascending aorta were performed with a partial-occlusion clamp and 6-0 monofilament suture. Graft flow was measured intraoperatively via a Doppler probe (Transonic Systems, Ithaca, NY, USA).

Parameters and Time Points

The following parameters were recorded: heart rate, MAP, mean central venous pressure (CVP), mean pulmonary artery pressure (PAP), pulmonary capillary wedge pressure (PCWP), systemic vascular resistance (SVR), pulmonary vascular resistance, and CI, as well as treatment with norepinephrine and milrinone. The time points of measurement were at baseline 5 to 10 minutes after sternotomy (T0), after displacement of the heart just before occlusion of the target vessel (T1), and during performance of the distal anastomosis, 5 minutes after occlusion of the target vessel (T2).

The total number of bypasses, the amount of intraoperative fluid infused, and the intraoperative blood loss were recorded. Graft flow and time of occlusion of the target vessel were recorded for each bypass. Creatine kinase isoenzyme MB, creatine kinase, and troponin I were measured at 2, 6,

Table 3. Anastomosis to Posterior Wall: Hemodynamic Parameters with the Vacuum-Assisted Apical Suction (VAS) Device or the Deep Pericardial Traction Suture (DPTS) Technique*

Variable/Group	T0	T1		T2	
			P		*P*
CI, L/min per m²					
VAS	2.6 ± 0.6	2.6 ± 0.7	1	2.7 ± 0.7	1
DPTS	2.6 ± 0.6	2.2 ± 0.4	.76	2.1 ± 0.4	.68
CVP, mm Hg					
VAS	6 ± 4	11 ± 5	.18	8 ± 3	1
DPTS	8 ± 3	12 ± 7	.32	10 ± 1	1
MAP, mm Hg					
VAS	85 ± 17	73 ± 10	.41	72 ± 6	.43
DPTS	76 ± 7	72 ± 6	.57	71 ± 3	.48
PAP, mm Hg					
VAS	21 ± 8	19 ± 11	1	17 ± 6	1
DPTS	20 ± 7	25 ± 5	.18	21 ± 4	1
PCWP, mm Hg					
VAS	11 ± 17	12 ± 7	1	12 ± 2	1
DPTS	9 ± 2	**17 ± 5**	**.01**	14 ± 2	.17
SVR, dyn s/cm⁵					
VAS	1311 ± 568	1229 ± 148	1	1007 ± 283	1
DPTS	1065 ± 300	1138 ± 277	1	1159 ± 259	1
PVR, dyn s/cm⁵					
VAS	171 ± 126	151 ± 85	1	104 ± 54	1
DPTS	155 ± 53	149 ± 69	1	154 ± 70	1
Norepinephine, µg/kg per min					
VAS	0.24 ± 0.22	0.08 ± 0.05	.34	0.07 ± 0.05	.07
DPTS	0.22 ± 0.36	**0.08 ± 0.01**	**.04**	0.06 ± 0.02	.08
Milrinone, µg/kg per min					
VAS	0.04 ± 0.07	0.10 ± 0.05	.25	0.10 ± 0.05	.26
DPTS	0 ± 0	0.11 ± 0.10	.07	0.11 ± 0.11	.11

*Data are presented as the mean SD. Statistically significant differences ($P < .05$) compared with T0 are highlighted in boldface. Abbreviations are expanded in the footnote to Table 2.

24, 36, 48, and 120 hours after performance of the last anastomosis. Operation times, times of mechanical ventilation, times in an intensive care unit, and days in the hospital were compared.

Statistical Analysis

All normally distributed data are reported as the mean SD. Hemodynamic measurements at different time points were compared by repeated measures analysis of variance and the Bonferroni post hoc test. Differences between treatment groups were compared with the independent Student *t* test. A *P* value <.05 was considered statistically significant.

RESULTS

The two treatment groups did not differ with respect to any of the demographic data (Table 1). No operation was converted to cardiopulmonary bypass, and no perioperative mortality or myocardial infarctions occurred. There were no differences between the two treatment groups with respect to any of the hemodynamic parameters at baseline or to the differences between the hemodynamic values at baseline and those during the anastomoses to the anterior wall.

Tables 2 and 3 summarize the data for the hemodynamic parameters and catecholamine therapy at baseline and during

Table 4. Bypass Parameters*

Parameter/Group	Anterior Wall	Lateral Wall	Posterior Wall
Ischemic time, min			
VAS	11 ± 3	10 ± 3	8 ± 4
DPTS		13 ± 7	9 ± 2
Graft flow, mL/min			
VAS	47 ± 31	35 ± 18	34 ± 22
DPTS		28 ± 19	50 ± 46

*Data are presented as the mean ± SD. VAS indicates vacuum-assisted apical suction (device); DPTS, deep pericardial traction suture (technique).

anastomoses of the lateral and posterior walls. During exposure of the lateral wall, the CVP increased in the VAS group, and CVP, PAP, and PCWP increased in the DPTS group.

When the posterior wall of the heart was exposed, no significant hemodynamic changes were noted in the VAS group. In the DPTS group, the PCWP and the administered norepinephrine dose increased during this procedure.

The differences between two treatment groups at one time point were significant only for the CVP (12 mm Hg in the VAS group versus 19 mm Hg in the DPTS group, $P = .047$) after positioning the heart (T1).

There were no differences in ischemic times or graft flow between the twp treatment groups (Table 4). There were also no differences in the courses of postoperative myocardial markers (Table 5). Finally, the two groups did not differ with respect to catecholamine support, duration of mechanical ventilation, time in the intensive care unit, or time in the hospital (Table 6).

DISCUSSION

Apart from the controversy about the potential benefits of OPCAB surgery, which has been the subject of numerous studies, there is no doubt that if off-pump surgery is performed, effective epicardial stabilization and heart positioning are crucial [Mueller 2002; Chang 2004].

With the establishment of OPCAB surgery for not only revascularization of the anterior wall but also the lateral and inferior walls, the techniques for exposing the latter on the beating heart underwent continuous improvement, and technical devices soon became commercially available. While many surgeons continued the deep pericardial suture technique, which requires no special devices and has no extra costs, apical suction devices became established for heart positioning. Besides the deep pericardial suture technique, other modifications of the operation originally introduced by Ricci et al have been described (eg, the lateral pericardial suture technique [Ricci 2000]). None of these modifications have been reported to have obvious advantages [Biancari 2010]. In particular, techniques that avoid enucleation of the heart from the pericardial sac are no longer used for complete revascularization of the heart,

Table 5. Postoperative Myocardial Enzymes*

	Time					
Myocardial Enzyme	2 h	6 h	24 h	36 h	48 h	120 h
Creatine kinase, U/L						
VAS	98 ± 65	212 ± 187	372 ± 185	846 ± 444	993 ± 496	327 ± 365
DPTS	52 ± 25	122 ± 35	270 ± 166	528 ± 328	1610 ± 2002	132 ± 103
P	.64	.37	.25	.26	.48	.33
Creatine kinase isoenzyme MB, ng/mL						
VAS	1 ± 1	19 ± 22	19 ± 11	28 ± 15	27 ± 11	19 ± 7
DPTS	3 ± 2	4 ± 1	10 ± 9	18 ± 4	24 ± 20	16 ± 12
P	.30	.45	.23	.24	.76	.10
Troponin I, ng/mL						
VAS	2.5 ± 3.8	11.1 ± 21.8	14.5 ± 24.0	19.8 ± 35.6	17.4 ± 28.1	3.4 ± 7.5
DPTS	5.3 ± 10.2	2.3 ± 3.1	1.6 ± 1.0	3.0 ± 0.5	2.8 ± 2.3	0.5 ± 0.6
P	.26	.24	.17	.46	.34	.48

*Data are presented as the mean ± SD. VAS indicates vacuum-assisted apical suction (device); DPTS, deep pericardial traction suture (technique).

Table 6. Auxiliary Outcome Parameters*

	VAS	DPTS	*P*
Duration of operation, h	4.08 ± 0.51	4.44 ± 1.56	.51
Intraoperative blood loss, mL	1010 ± 638	1286 ± 727	.59
Time on respirator, h	14 ± 7	13 ± 8	.96
Time in ICU, h	22 ± 7	45 ± 65	.52
Time in hospital, d	13 ± 6	15 ± 5	.75

*Data are presented as mean ± SD. VAS indicates vacuum-assisted apical suction (device); DPTS, deep pericardial traction suture (technique); ICU, intensive care unit.

because these techniques require higher forces to the lateral or posterior wall to expose the target area.

Thus, the two widely used techniques for OPCAB surgery have been addressed in the present study. Regarding such outcome variables as hospital stay, time in the intensive care unit, or time of mechanical ventilation, we observed no differences between the two techniques. Because we expected this result, our focus in this study was on the impact of the surgical technique on the patient's hemodynamics during the operation.

Both the clear protocol for intervention to stabilize hemodynamic parameters and the performance of all operations by the same surgeon improved the consistency of this study. A strict algorithm for intraoperative anesthesia management was essential to reduce the bias of therapeutic measures. We followed the guidelines that other authors have proposed [Chassot 2004]. Intensive hemodynamic monitoring was used as the basis of fluid and catecholamine management. In OPCAB surgery, hemodynamic monitoring is not standardized, but use of the combination of a pulmonary artery catheter and transesophageal echocardiography has been recommended [Gurbuz 2007]. There were no intraoperative myocardial infarctions, and no conversions to cardiopulmonary bypass. Patients of both treatment groups could be hemodynamically stabilized at all times during surgery, and direct comparison of hemodynamic parameters did not reveal many significant differences between the two groups.

A consistent fluid-management and catecholamine regimen administered by an experienced anesthesiology team and the performance of all procedures by a single surgeon with more than 10 years of expertise in both OPCAB techniques led to few confounders that affected the data. Therefore, we were able to demonstrate that the two groups differed with respect to the course of the changes in hemodynamic parameters. The more profound changes occurred when the lateral wall was exposed. Especially during surgery of the lateral wall of the heart, one must accept a compromise between hemodynamic impairment and exposure of the target vessel. This tradeoff is also reflected in the hemodynamic data from other clinical and experimental studies [Beckman 2003; Chang 2004]. In the present study, the mean myocardial contractility of the patients in the two groups was not critical, as quantified by ejection fractions >60% and given that we excluded patients with acute myocardial infarction. In patients with a higher degree of functional impairment, differences between the cardiac-positioning techniques might be higher.

The increases in CVP and PCWP are the most sensitive parameters for reflecting the impact of the surgical techniques. The increases in CVP and PCWP were partly a direct cause of dislocation of the heart and partly because of the fluid load given to reach the optimal filling pressure. Although both sides of the heart were involved in these changes, in most patients the right ventricle reached maximal preload earlier, which prohibited further fluid loading and more extensive dislocation of the heart. Echocardiography was a useful tool for assessing the risk of fluid overload in these situations. In contrast to the results of other studies, we did not record a significant drop in the CI in either of the treatment groups. That finding could have been caused by a different population of patients, but it also could have been due to the use of optimized fluid management and fluid therapy in this study.

Different results concerning the impact on hemodynamic stability have previously been reported. Gummert et al [2008] could not document any significant differences with respect to CI, MAP, heart rate, and the intrathoracic blood volume index. Ustunsoy et al [2007], however, reported an extensive difference in hemodynamic impairment between VAS and DPTS treatment groups. All measured parameters, including CI, SVR, and MAP, showed significant differences, but catecholamine therapy and CVP and fluid management were not mentioned.

The function of a positioning device can be measured with respect to two qualities. The first is the extent of hemodynamic impairment that occurs during heart displacement and the quality of exposure. The second is reflected in the time needed for the anastomoses and the quality of the anastomoses. Because long-term patency could not be investigated in this study, only graft flow at the end of the operation was assessed. The two techniques showed no differences with respect to graft flow.

Besides the positioning of the heart, stabilizing devices are also used in OPCAB surgery to stabilize the anastomosis site. Beckman et al [2003] compared the influences of different positioning devices in combination with mechanical and vacuum stabilizing devices in an animal model. These investigators emphasized that the role of the stabilizing device for hemodynamic stability is not yet fully understood. In our study, we used the Octopus vacuum stabilizing device in all patients. Its impact on the hemodynamics of our patients seemed small but was not quantified.

The displacement of the heart has the highest impact on the hemodynamics during OPCAB surgery. The influences of different factors have been well described by Gründeman et al [1999, 2001, 2004]. There are mainly three different possibilities for how the heart can be displaced: upward pushing of the heart, applying traction on the heart, or a combination of both. Understanding why one method of cardiac dislocation outperforms others requires that the different mechanisms of hemodynamic impairment be understood. In both techniques, the tilting of the heart into a vertical position requires blood to flow upwards into the ventricular cavities and therefore a higher atrial pressure to maintain an adequate end-diastolic volume. Furthermore, pressure exerted by the retractor or the sternum on the ventricular wall might restrict wall motion locally and reduce ventricular dimensions.

Finally, a vertical position of the heart distorts the mitral and tricuspid annuli and may cause significant regurgitation. George et al [2007] demonstrated in their echocardiographic study with three-dimensional reconstruction of the atrioventricular geometry and mitral valve that the use of the deep suture technique causes a higher degree of dysfunction. Their findings could explain our results of less impaired hemodynamics and a lower preload pressure when the apical suction device was used. With either technique, it is important to maintain a straight axis of the heart to avoid inflow or outflow obstructions or insufficiency of the atrioventricular valves. This unwanted kinking of the heart at or below the atrioventricular plane is provoked by insufficient longitudinal traction when the vacuum positioning device is used or when placement of the deep pericardial suture is inadequate. We did not record or analyze changes in mitral or tricuspid regurgitation in our patients to study the coherence of these events.

A further thought concerns the longitudinal shortening of the ventricles that could be impeded by the use of apical suction devices [Abicht 2011]. The swivel joint of the suction cup enables systolic rotation of the apex but inhibits any change in position. This is a theoretical disadvantage of apical suction devices compared with pericardial suture techniques, in which the shortening of the long axis is not impeded. The concept that the enucleated heart should move freely is a guideline for maintaining good hemodynamics during OPCAB surgery [Mueller 2002].

The extent to which the above-mentioned interacting mechanisms contribute to the noted hemodynamic changes remains unclear but would be difficult to elucidate in any clinical study.

Besides this discussion of physical and physiological advantages or disadvantages of either of these techniques, one must remember that the handling of the heart by the surgeon will always remain a crucial factor when displacing the heart. Personal preference, effort, and especially intensive training on the technique used have a major impact on hemodynamic stability during OPCAB procedures.

One of the very few significant differences shown in the latest prospective randomized trial of >2203 patients is the higher number of planned but unperformed grafts in the off-pump group. With respect to these results, the positioning of the heart should be considered one of the key factors for successful OPCAB surgery [Shroyer 2009].

CONCLUSION

Exposure of the posterior heart wall with an apical suction device or with a deep pericardial suture technique is a safe and effective procedure. We could not demonstrate any differences regarding early revascularization results; however, our study supports the findings of previous studies that apical suction devices are associated with less impairment during dislocation of the heart in OPCAB surgery, compared with pericardial traction suture.

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