

## **Novel Instrumented Retractor to Monitor Tissue Disruptive Forces During Median Sternotomy**

Gregory Buckner<sup>2</sup>, Nicholas Jardine<sup>2</sup>, Aaron Kiefer<sup>2</sup>, Nigel Campbell<sup>2</sup>, Masha Kocherginsky<sup>2</sup>,  
Gil Bolotin<sup>1</sup>

<sup>1</sup> *Cardiac Surgery, Rambam Medical Center, Haifa, Israel,* <sup>2</sup> *Department of Mechanical and Aerospace Engineering, North Carolina State University, Raleigh, NC, USA*

**Objectives:** Acute and chronic pain after median sternotomy is common and often underestimated. The mechanical retractors used for the median sternotomy exert significant forces on the skeletal cage. Our hypothesis is that instrumented retractors can be developed to enable real-time monitoring and control of retraction forces. This may provide equivalent exposure with significantly reduced forces and tissue damage, and thus less post-operative pain.

**Methods:** A novel instrumented retractor was designed and fabricated to enable real-time force monitoring during surgical retraction. Sixteen mature sheep underwent median sternotomy. Eight median sternotomies were retracted at a standard “clinical pace” of  $7.25 \pm 0.97$  minutes to 7.5 cm without real-time monitoring of retraction forces. The other eight median sternotomies were retracted to the same exposure using real-time visual force feedback and, consequently, a more deliberate pace of  $12.05 \pm 1.73$  minutes ( $p < 0.001$ ). Retraction forces, blood pressure, and heart rate were monitored throughout the procedure.

**Results:** Full retraction resulted in an average force of  $102.99 \pm 40.68$  N at the standard clinical pace as compared to  $64.68$  N with force feedback (a 37.2% reduction,  $p = 0.023$ ). Standard retraction produced peak forces of  $368.79 \pm 133.61$  N, whereas force feedback yielded peak forces of  $254.84 \pm 75.77$  N (a 30.9% reduction,  $p = 0.084$ ). Heart rate was significantly higher during standard clinical retraction ( $p = 0.024$ ).

**Conclusions:** Using the novel instrumented retractor resulted in lower average and peak retraction forces during median sternotomy. Moreover, these reduced retraction forces correlated with a reduction in animal stress as documented by lower heart rate.

## Long Term Experience of Wrapping the Ascending Aorta with Dacron Mesh as Definitive Treatment for Aneurysmal Dilatation

Oved Cohen<sup>1,2</sup>, Jonah Odum<sup>1</sup>, David De La Zerda<sup>1</sup>, Gil Bolotin<sup>2</sup>, Hillel Laks<sup>1</sup>

<sup>1</sup> Division of Cardiac Surgery, Surgery, David Geffen School of Medicine at UCLA, Los Angeles CA, USA, <sup>2</sup> Cardiac Surgery, Surgery, Rambam Medical Center and the Rappaport Family Faculty of Medicine, Technion Medical School, Haifa, Israel

**Background:** The management of the mildly to moderately dilated ascending aorta in cardiac surgery remains controversial. Therapeutic options have included radical aortic resection with synthetic graft substitution, external aortic reinforcement or wrap with or without partial aortic wall excision, and a watch and wait approach.

**Methods:** Over the last 20 years, 102 patients with aneurysmal dilatation of the ascending aorta underwent wrapping of the ascending aorta with a fine Dacron mesh from the ventricular-aortic junction to the origin of the innominate artery. For the last ten years, the wrap was anchored to the aortic annulus with pledgeted sutures. Aortic diameters up to 6 cm, without focal areas of thinning, were wrapped. Aortic diameters > 6 cm, or with focal thinning, underwent tailored aortic wall resection and wrapping. Primary endpoints of the study included mortality, aortic diameter growth, dissection and/or rupture.

**Results:** The mean age of the group was  $54.7 \pm 19.54$  yr (range, 12 to 90). A single patient underwent aortic wrapping without cardiopulmonary bypass. Sixty-six patients (65%) required additional aortic valve surgery. Five patients (5%) had reinforcement of dilated sinuses with glutaraldehyde-treated pericardial patches combined with wrapping. Twenty-seven patients (26%) had combined coronary and valve surgery, and two patients had coronary revascularization alone. There was neither early nor hospital mortality. Among the 81 patients (79%) we were able to contact, there were 7 (7%) late deaths at 0.5, 1, 3 and 9 years after operation, unrelated to aortic pathology. Various levels of follow up were obtained in the 88 patients (86.2%). In 78 patients, echocardiograms, CT angiograms or MR angiograms were obtained. Two of these patients had developed aneurysmal dilatation of the sinuses below the wrap and required reoperation. No patient in whom the mesh wrap was anchored to the aortic annulus required reoperation. All eighty-one patients that were contacted by us, and followed by referring physicians, were asymptomatic and free of problems related to the aorta. The mean preoperative diameter of the ascending aorta was  $49.2 \pm 7.8$  mm (mean  $\pm$  SD) (range: 35 to 87). The mean post-wrap intraoperative diameter was  $32.8 \pm 3.5$  mm (range: 20 to 45). The mean follow-up postoperative aortic diameter was  $35.3 \pm 5.7$  mm. The average change in the aortic diameter during the follow up period was  $2.77 \pm 2$  mm (mean  $\pm$  SD), a mean of 8%. The mean follow-up period was 5.7 years, median: 4.77 years; range: 9 days – 21 years. There were no infections or other early complications related to the wrap.

**Conclusions:** Dacron mesh support of the moderately dilated aneurysmal ascending aorta, alone or in conjunction with coronary revascularization, aortic root surgery and/or valvular operations, is safe and durable. Dacron mesh is transparent and stretchable, permitting tight girdling of the aorta. These properties prevent hematoma formation, facilitate proximal vein graft anastomoses, and provide visualization and access to aortic suture lines. Finally, this technique retards further aortic dilation, altering the natural history of aortic aneurysms.

## **Can LIMA-RIMA 'T-Graft' Supply the Right Coronary System?**

Leonid Ruderman, Dan Abrahamov, Menachem Matsa, Amir Ganiel, David Mozalbat,  
Jaffer Assala, Yaron Ishai, Gideon sahar

*Cardiothoracic Surgery, Soroka University Medical Center, Beer Sheva, Israel*

### **Study objectives:**

In the current literature, there is uncertainty whether RIMA 'T-GRAFT' can safely supply multiple coronary bypasses, and whether it can provide the RCA system. In the present study, we evaluate the outcome of patients who underwent CABG surgery using LIMA-RIMA 'T-graft' of more than 4 bypasses and the distal anastomosis of the RIMA was to the RCA system.

### **Methods:**

Between 6.2005 and 11.2006, 30 consecutive patients underwent the above mentioned surgery. Average age was 56.2, female gender was 13.3 % ,the incidence of diabetes- 26.7%, moderate + left ventricular dysfunction -13.3%, left main disease - 26.7%, unstable angina- 53.3%, average number of bypasses was 4.63, average EUROSCORE -3.41%.

### **Results:**

There was no mortality in our series; all patients were weaned from mechanical ventilation in less than 24 hours. Postoperative course was uneventful and patients were discharged in less than 7 days. One patient had a superficial wound infection that did not necessitate surgical intervention.

In mid term follow up (1.5 year) – there was no mortality, no admissions due to ischemic heart disease, and no complaints of angina pectoris. All patients had an up to date echocardiography study. LV function was unchanged in 20 patients and improved in ten patients.

### **Conclusion:**

LIMA RIMA 'T'-graft can safely be used for multiple bypasses. With proper technique, The RIMA can supply the RCA territory with good mid term results. By that, we can avoid harvesting other conduits and use the best conduit for all the heart.

## Prognostic Value of Predictors for Prolonged Mechanical Ventilation after Cardiac Surgery

Alexander Lipey<sup>1</sup>, Benjamin Medalion<sup>1</sup>, Abed Assali<sup>2</sup>, Eitan Snir<sup>1</sup>, Erez Sharoni<sup>1</sup>,  
Ran Kornowski<sup>2</sup>, Hana Vaknin<sup>2</sup>, Alon Shtamler<sup>1</sup>, Zvika Raviv<sup>1</sup>, Philip Biderman<sup>1</sup>,  
Bernardo Vidne<sup>1</sup>, Eyal Porat<sup>1</sup>

<sup>1</sup> Cardiothoracic Surgery, <sup>2</sup> Cardiology, Rabin Medical Center, Petach Tikva, Israel

**Background:** Prolonged mechanical ventilation after cardiac surgery is associated with higher mortality and morbidity. Identification of preoperative variables, which may lead to prolonged mechanical ventilation, may help develop better strategies for postoperative ICU management. The aim of our study was to identify risk factors for prolonged postoperative mechanical ventilation.

**Methods:** Four hundred and eight consecutive patients who underwent coronary artery bypass grafting (CABG) with or without aortic valve replacement (AVR) composed the study population. Patients were classified as those ventilated less than 48 hours – group I (396 patients) and those ventilated more than 48 hours – group II -prolonged ventilation (12 patients). Multivariable analysis was used for risk factors identification.

**Results:** Postoperative mortality for patients in group I was 1.8% compared with 42% for group II ( $p < 0.001$ ). Preoperative predictors for prolonged mechanical ventilation included older age (OR=1.1,  $p = 0.03$ ), emergency surgery (OR=4,  $p = 0.02$ ), and lower ejection fraction (OR=1.1,  $p < 0.001$ ). The addition of intraoperative variables to the model adds combined CABG and AVR as a predictor for prolonged ventilation (OR=6,  $p = 0.04$ ).

**Conclusions:** The ability to identify patients at increased risk for prolonged mechanical ventilation may allow the development of pre-emptive strategies to optimize patient's condition and ICU management.

## Preoperative Hemoglobin Level as a Predictor for Outcome after Cardiac Surgery

Avi Fuks<sup>1</sup>, Benjamin Medalion<sup>1</sup>, Abed Assali<sup>2</sup>, Eitan Snir<sup>1</sup>, Erez Sharoni<sup>1</sup>, Philip Biderman<sup>1</sup>, Zvi Raviv<sup>1</sup>, Ran Kornowski<sup>2</sup>, Hana Vaknin<sup>2</sup>, Alon Shtamler<sup>1</sup>, Bernardo Vidne<sup>1</sup>, Eyal Porat<sup>1</sup>

<sup>1</sup> Cardiothoracic Surgery, <sup>2</sup> Cardiology Department, Rabin Medical Center, Petach Tikva, Israel

**Background:** Anemia is a known risk factor in many fields of medicine. The purpose of this study was to assess how pre-operative hemoglobin levels affect the outcome after cardiac surgery.

**Methods:** The data set includes 408 consecutive patients who underwent coronary artery bypass surgery in our institution. We studied the patients according to their preoperative hemoglobin (Hb) levels, Group A (Hb $\leq$ 11 mg/dl, 41 patients), Group B (Hb $>$ 11 mg/dl, 367 patients). Endpoints studied were perioperative mortality, prolonged ICU stay ( $>$ 72 hours), and prolonged hospital stay ( $>$ 10 days).

**Results:** There were more females in group A (18% vs. 8%,  $p=0.007$ ), and more hypertension (12 vs. 6,  $p=0.04$ ). Patients in group A were older ( $69\pm 11$  vs.  $66\pm 10$ ,  $p=0.04$ ), and had reduced preoperative creatinine clearance ( $59\pm 34$ ,  $85\pm 25$ ,  $p<0.01$ ).

Perioperative mortality was higher in group A, 12% compared with 3% in group B ( $p=0.02$ ). More patients in group A had Prolonged ICU stay, 16% compared with 6% in group B (0.05). More patients in group A had Prolonged hospital stay, 23% compared with 5% in group B ( $<0.001$ ). After adjustment for other confounding factors, multivariable logistic regression analysis identified Hb $<$ 11 mg/dl as an independent predictor for perioperative mortality (OR=5.6,  $p=0.001$ ).

**Conclusions:** Hb $<$ 11 mg/dl is an independent predictor for perioperative mortality and prolonged length of stay after cardiac surgery. Hemoglobin Correction should be considered prior surgery.

## **Successful Treatment of Disseminated Cutaneous Trichosporon Asahii Infection with Voriconazole in a Heart Transplant Recipient: The Importance of Multidisciplinary Approach.**

Tuvia Ben Gal<sup>1</sup>, Benjamin Medallion<sup>2</sup>, Bishara Jihad<sup>3</sup>, Morad Wattad<sup>3</sup>, Silvio Pitlik<sup>3</sup>, Dean Ad-El<sup>4</sup>, Moshe Salai<sup>5</sup>, Moshe Israeli<sup>6</sup>, Alexander Yussim<sup>7</sup>, Avital Porter<sup>1</sup>, Victoria Yaari<sup>1</sup>, Zmira Samra<sup>6</sup>, Eyal Porath<sup>2</sup>, Alexander Battler<sup>1</sup>

<sup>1</sup> Cardiology, Rabin Medical Center, Petach Tikva, Israel, <sup>2</sup> Cardiothoracic Surgery, <sup>3</sup> Infectious Diseases, <sup>4</sup> Plastic Surgery, <sup>5</sup> Orthopedic Surgery, <sup>6</sup> Laboratory of Clinical Microbiology, <sup>7</sup> Tissue Typing, Laboratory, <sup>8</sup> Organ Transplantation, Rabin Medical Center, Petach Tikva, Israel

**Purpose:** Infections with uncommon fungal pathogens are more frequently reported in immunocompromised hosts, particularly among hematological patients and transplant recipients. We report what we believe to be the first case of successful management of disseminated cutaneous *Trichosporon asahii* infection with orally administered voriconazole in a heart transplant recipient.

**Methods and Materials:** A 59-year-old man with end-stage non ischemic cardiomyopathy was ventilated and supported with high doses of inotropes and an intra-aortic balloon pump for 3 days before he underwent a successful orthotopic heart transplantation at April 12<sup>th</sup> 2007. His pre-transplant assessment revealed reversible elevated pulmonary vascular resistance and pre-renal azotemia. His immediate post operative recovery was complicated with worsening signs of right ventricular failure despite NO, sildenafil and diuretic therapy. His kidney function deteriorated requiring emergent hemodialysis. A biopsy proven acute rejection was treated with high dose steroids. While in the cardiac intensive unit, a black skin lesion was seen in his right leg diagnosed by the dermatologist as small necrosis of the skin due to the long standing severe edema. As the skin lesion enlarged, culture from a punch biopsy of the lesion showed growth of *Trichosporon Asahii*. Oral voriconazole 200 mg twice a day was started.

**Results:** Despite continuous treatment with the recommended voriconazole dose, local progression of the skin lesion was not halted. Below knee amputation was considered but eventually not done due to rapid dissemination of the fungal infection to both inner thighs and left hand. The mycophenolate mofetil was suspended and as the Immuknow levels were low trough levels of tacrolimus were maintained low. The voriconazole dosage was doubled after blood samples sent abroad found low levels of the drug. During the next days the dissemination of the lesions stopped. Due to improvement in his renal function, the hemodialysis was suspended, the right ventricle gradually recovered and the edema resolved. Surgical debridement was done and homograft skin was transplanted. Two weeks later, autologous skin grafts were taken from the outer right thigh and all the wounds were covered. This last skin grafting was very successful and by August 7<sup>th</sup> the patient was sent home. The voriconazole dose was reduced to 600 mg a day but MMF was not re-introduced yet (20<sup>th</sup> Sept. 2007).

**Conclusions:** The first case of successful management of disseminated cutaneous *Trichosporon asahii* infection with orally administered voriconazole in a heart transplant recipient is described. The multi disciplinary approach was essential for achieving this favorable outcome.

## **Surgery for Hypertrophic Obstructive Cardiomyopathy**

Boris Orlov<sup>1</sup>, Yuri Peisahovich<sup>1</sup>, Avinoam Shiran<sup>2</sup>, Moshe Y Flugelman<sup>2</sup>, Dan Aravot<sup>1</sup>

<sup>1</sup>*Department of Cardiothoracic Surgery,* <sup>2</sup>*Department of Cardiovascular Medicine, Carmel Medical Center, Haifa, Israel*

**BACKGROUND:** Surgical treatment of patients with obstructive cardiomyopathy (HOCM) includes relief of left ventricular outflow tract (LVOT) obstruction and correction of mitral regurgitation and is indicated when disabling symptoms refractory to maximal medical management are present. Transaortic septal myectomy (Morrow procedure) is regarded as a standard surgical approach for this condition. Recent advances in understanding the anatomy and physiology of LVOT obstruction resulted in several changes in surgical strategies. Standard myectomy can be performed in combination with one of several techniques of mitral valve repair for correction of structural abnormalities of the mitral apparatus in patients with HOCM.

We review our experience of surgical management of patients these using several techniques for different mitral pathologies.

**METHODS:** Four patients with HOCM were operated between September and October 2006. Mean age was 63.5 years. All patients had typical marked systolic anterior motion (SAM) resulting in severe LVOT obstruction and severe mitral regurgitation. Transesophageal echocardiography was used in all patients preoperatively and postoperatively to guide and assess adequacy of resection, LVOT gradient and mitral valve function. Concomitant coronary artery bypass grafting was performed in two patients.

In two cases septal myectomy was done through standard transaortic approach. The others two patients had additional pathologic changes of the mitral valve, (ruptured chords to the posterior leaflet, anterior leaflet enlargement) requiring surgical intervention on the mitral valve. In one the patients, we used transatrial transmitral approach to the LVOT with temporary detachment of the anterior mitral leaflet that proved to be very helpful for extended myectomy. Mitral valve repair included resection of posterior leaflet due to ruptured chords, anterior leaflet extension and annuloplasty. In the other case we applied the edge-to-edge Alfieri stitch technique, which eliminated the SAM, LVOT gradient, as well as the MR.

**RESULTS:** All four patients survived surgery. No ventricular septal perforation occurred, and none of the patient needed permanent cardiac pacing. Serial postoperative echocardiography demonstrated that the LVOT gradient, mitral regurgitation and SAM of the mitral valve were significantly reduced if not eliminated.

**CONCLUSIONS:** Surgical relieve of LVOT obstruction produce significant hemodynamic improvement in patients with severe symptomatic HOCM. Choice of the surgical method depends on the anatomic and physiologic derangement of the LVOT and the underlying pathology of mitral regurgitation. Transatrial-transmitral approach to the LVOT proved to be very helpful for extended myectomy.

### **Stents and CABG: Financial Impact.**

Shuli Silberman<sup>1</sup>, Amir Solomonica<sup>2</sup>, Avraham Oren<sup>2</sup>, Adi Butnaro<sup>3</sup>, Dani Bitran<sup>1</sup>,  
Amir Shmueli<sup>2</sup>

<sup>1</sup> *Cardiothoracic Surgery, Shaare Zedek Medical Center,* <sup>2</sup> *School of Public Health, Faculty of Medicine, Hebrew University,* <sup>3</sup> *Cardiology, Shaare Zedek Medical Center, Jerusalem, Israel*

*Background:* Coronary artery revascularization with either angioplasty/stent implantation (PCI) or bypass surgery (CABG) is common, and clinical results have been comparable. However, the burden on health care systems has not been widely studied.

*Methods:* Our departmental database was queried for all patients undergoing pure CABG between 2000-2006 (group 1). Subsequently, all patients undergoing first time coronary intervention (PCI or CABG) at Shaare Zedek Medical Center between 2002-2004 were enrolled (group 2). Hospital records as well as outpatient records were reviewed to document utilization of health care facilities and cost.

*Results:* In group 1 there were 1121 patients. Of these, 315 had prior PCI and 22 had prior CABG. The mean interval between PCI-CABG was 2.4 years, in 116 (37%) within 1 year of the initial procedure. The mean interval between CABG-CABG was 13 years, in 2 (9%) within 1 year. Group 2 included 432 patients: 180 received a bare metal stent (BMS), 71 a drug-eluting stent (DES), and 181 underwent CABG. Data from a pilot group of 25 patients was available 1 year after intervention: 9 BMS, 9 DES and 7 CABG. Six (33%) patients in the PCI group required a repeat procedure, compared to none in the CABG group. Initial cost of hospitalization per patient was \$11643 for CABG compared with \$6329 for PCI. By 1 year the cost per patient was unchanged for CABG and increased to \$9344 for PCI, due to re-intervention. Utilization and costs of ambulatory services were similar in both groups.

*Conclusions:* While initial cost of CABG is higher than that of PCI, patients undergoing PCI require more repeat interventions and at shorter intervals. At longer follow-up we may expect to see more need for re-intervention in both groups. With limited resources available, the choice of procedure should take into account not only clinical benefit, but also long term financial considerations.