

(16%). Half of the initial PJ were gone, and in 10% of subjects a new jet was detected. Hemolytic indices (haptoglobin, LDH, reticulocytes, bilirubin, hemoglobin, hematocrit) were not different in those with vs. those without PJ, early or late after surgery.

**Conclusion:** Small paraprosthetic jets are frequent after mitral valve replacement with the continuous suture technique. They are not associated with long-term hemolysis and may resolve spontaneously in the first year after surgery.

#### 1041-20 Tissue-mediated Porcine Bioprosthesis at the Aortic Position: Five Year Clinical Experience

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**Introduction:** The tissue-mediated porcine bioprostheses are freshly mounted and dilated for correct functional sizing and commissural alignment. They are then fixed under low pressure. These valves closely approximate the natural leaflet geometry, reduce opening commissural bending stresses and provide a solution to structural failure from calcification and tears.

**Method:** To evaluate the clinical performance of the bioprostheses at the aortic position 175 of the 207 tissue-mediated bioprostheses in our centre were implanted at the aortic site between 1991 and 1996. There were 22 mitral, 2 tricuspid and 4 multiple replacements. The mean patient age was 73 years (range 56-94) with 103 males and 72 females. Pre-operatively 63% of patients were in NYHA functional class III or IV. Concomitant procedures were performed in 28% of patients. Follow-up was 100% (total cumulative follow-up 303.3 patient years). The prostheses were evaluated using standard Edmunds guidelines.

**Results:** The hospital mortality in this elderly population was 9.1% [CI 4.9-13.4] with no early valve related deaths. Patient survival at five years was 81% (SE 8.6). Valve related complication rates and freedom from valve related events at 5 years are as follows:

| Events                 | Rates (%/patient/year (episodes)) | Freedom at 5 years |
|------------------------|-----------------------------------|--------------------|
| Thromboembolism        | 1.3 (4)                           | 97.2% (SE 1.9)     |
| Haemorrhage            | 0.3 (1)                           | 99.3% (SE 0.4)     |
| Bacterial endocarditis | 0.3 (1)                           | 99.2% (SE 0.5)     |
| Nonstructural failure  | 0.0 (0)                           | 100% (SE 0.0)      |
| Structural failure     | 0.0 (0)                           | 100% (SE 0.0)      |
| Re-operation           | 0.3 (1)                           | 99.2% (SE 0.5)     |

At follow-up 97.7% survivors were in NYHA functional class I or II.

**Conclusions:** Following implantation at the aortic site there were no early valve related deaths and valve related complications were minimal with no episode of nonstructural or structural failure. There was a significant clinical improvement in patient symptoms. Long term clinical follow-up is essential to fully evaluate this promising new porcine bioprosthesis.

#### 1041-21 Flow Characteristics in Diastolic LV Filling Vary Significantly With Different Mitral Valve Prostheses: An In-Vitro Study

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**Background:** The non-invasive assessment of LV diastolic filling has focused particularly on determining the pattern of filling, which is altered when mitral valve prostheses are implanted. Our goal in this *in-vitro* study was to utilize the left heart pulsed flow simulator at CalTech to explore the impact of mitral valve design and orientation on LV filling characteristics.

**Methods:** Three mitral valve prostheses were selected for insertion in the mitral position of the pulsed flow simulator with a flexible and transparent LV model under pseudo-physiological flow and pressure conditions; preload = 8 mmHg, afterload = 100 mmHg, SR = 35%, HR = 72 bpm and CO = 2-5 l/min. A 29 mm St. Jude Medical (SJM) bileaflet valve, a 29 mm Medtronic-Hall (MH) tilting disc valve, and a 27 mm bioprosthesis. A 23 mm Porcine bioprosthesis was selected for the aortic position. Digital Particle Image Velocimetry (DPIV) and Doppler ultrasonography, Vingmed CFM800, were applied for measurement and diagnostic imaging.

**Results:** DPIV images revealed detailed flow characteristics for each valve prosthesis. In contrast to the tissue valve that induced an efficient filling with centrally directed flow directed towards the "cardiac apex", as in the natural valve with low wall shear stresses, both MH and SJM generated multiple jet flows directed toward LV walls. MH valve was oriented with the major orifice facing the septum generated a swirling flow originated along the septum wall, rolling along the posterior wall to the outflow tract leaving a semi-stagnation region in the center of the cavity with maximum vorticities along the septum and posterior walls. SJM was oriented with the

three orifices in the anterior-posterior plane, induced a three jet flow which consisted of a central jet and two lateral ones directed toward the septum and posterior walls, with maximum shear stresses along the posterior wall. The 2D echocardiography and color Doppler flow mapping images correlated well with the DPIV results.

**Conclusions:** Unlike tissue mitral valve which induced a central flow with mild wall shear stresses, mechanical prostheses generated high-velocity, wall directed jets with maximum wall shear stresses.

#### 1041-22 In-Vitro Comparative Study by MRI and DPIV of Flow Through Normal and Thrombosed Bileaflet Aortic Valve: Velocity and Vorticity Mapping and Shear Stress Analysis

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**Background:** Although a proposed advantage of bileaflet mechanical valves is that if one leaflet is thrombosed shut, the second leaflet may continue to function normally, clinical experience suggests that patients with one thrombosed leaflet demonstrate impaired opening of the second leaflet and therefore, extremely high levels of wall shear stress. Our goal was to quantitatively assess the flow field generated by a thrombosed valve versus a normal bileaflet valve.

**Methods:** A prototype bileaflet aortic valve was constructed using a pair of pyrolytic carbon leaflets mounted in a transparent housing to allow for phased velocity encoded Magnetic Resonance Imaging and Digital Particle Image Velocimetry. The valve was then inserted into the aortic position of a non-compliant model. Pulsatile flow was generated by a blood pump at CO = 5 l/min, HR = 70 bpm, SR = 35%, preload = 10 mmHg, and, afterload = 100 mmHg. The DPIV study was conducted by using a double-pulse YAG: Nd laser sheet illumination.

**Results:** There was an extremely high degree of correlation between 3-D velocity vector directions and magnification between DPIV and MRI images. DPIV flow images past the fully open normal leaflets revealed a typical Karman wake with alternating, interfacial vortices at the leaflet edge. Shear stress analysis revealed mild wall values in the order of 10-15 dynes/cm<sup>2</sup> in the ascending aorta. When one leaflet was fixed closed, even though the second leaflet initially opened completely in early systole, a separated vortex rapidly developed between the downstream tip of the open leaflet and the sinus of Valsalva. This vortex is followed by extremely high shear stress regions, in the downstream, known as mixing layers inducing wall shear stress values exceeding 3500 dynes/cm<sup>2</sup>. As systole progressed, the vortex formed behind the open leaflet caused simultaneous partial closure of the normally opening leaflet.

**Conclusions:** The DPIV and MRI images provided robust 3-D flow field characterizations which can provide insight into the physiology of normal and abnormal prosthetic valves function.

#### 1042 Cardiovascular Surgery of Congenital Heart Disease

Monday, March 30, 1998, Noon-2:00 p.m.  
Georgia World Congress Center, West Exhibit Hall Level  
Presentation Hour: Noon-1:00 p.m.

#### 1042-154 Down-sized Homografts in Congenital Cardiac Surgery

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**Background:** Neonatal and infant cardiac surgery requiring valved homografts is increasingly performed. This has resulted in a shortage of appropriately-sized homografts. A technique for down-sizing large homografts has been described, but reported results are limited. We describe our early experience in the use of these down-sized homografts.

**Methods:** Neonates and infants undergoing congenital cardiac surgery using down-sized homografts were identified; surgical and follow-up records were reviewed. Age, weight, diagnosis, surgery, homograft size, complications, and follow-up status were evaluated.

**Results:** From June 1996 to April 1997, six neonates and infants aged 8 to 288 days (mean = 86; 3 < 18 days) weighing 2.8 to 6.2 kg (mean = 4.4) underwent cardiac surgery using 20-21 mm valved homografts down-sized to 12-15 mm bicuspid homografts. Surgeries were repair of pulmonary atresia/VSD (n = 5) and Ross procedure for aortic stenosis (n = 1). There was one operative death, unrelated to homograft size. In follow-up (5-14 months) 4 of 5 patients have "ace to no pulmonary insufficiency (PI); 1 of 5