Cardiac Transplant: Role of Echo
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Principal Approaches to Surgery for Advanced Heart Failure
Cardiac Transplantation
Mechanical Circulatory Support

CARDIAC TRANSPLANTATION

NUMBER OF HEART TRANSPLANTS REPORTED BY YEAR

Adult Heart Transplants Diagnosis

HEART TRANSPLANTS: Donor Age by Year of Transplant

For some retransplants a diagnosis other than myocardial was reported, so the total percentage of retransplants may be greater.
**Adult and Pediatric Heart Transplants**

Kaplan-Meier Survival by Age Group
(Transplants: January 1982 – June 2013)

- **Adult (N=100,806)**
- **Pediatric (N=11,384)**

**Median survival (years):**
- Adult = 10.3; Conditional = 13.0
- Pediatric = 15.3; Conditional = 20.0

JHLT. 2014 Oct; 33(10): 1009-1024

**ADULT HEART TRANSPLANTS BY ERA**
(Transplants: January 1982 – June 2013)

- 1992-2001 (N=39,368)
- 2002-2008 (N=24,823)
- 2009-6/2013 (N=16,200)

**Median survival (years):**
- Adult = 8.4; Conditional = NA
- Pediatric = 10.4; Conditional = NA

All pair-wise comparisons were significant at p < 0.0001 except cardiomyopathy vs. congenital.

JHLT. 2015 Oct; 34(10): 1244-1254

**ADULT HEART TRANSPLANTATION**
Kaplan-Meier Survival by Diagnosis
(Transplants: January 1982 – June 2013)

- Cardiomyopathy (N=46,386)
- CAD (N=41,505)
- Congenital (N=2,101)
- Retransplant (N=2,070)
- Valvular (N=3,575)

**Median survival (years):**
- Cardiomyopathy = 11.6; CAD = 9.4; Congenital = 14.6; Retransplant = 6.7; Valvular = 10.8

All pair-wise comparisons were significant at p < 0.0001 except cardiomyopathy vs. congenital.

JHLT. 2014 Oct; 33(10): 996-1008

**Surgical Heart Transplant Techniques**

- **Biatrial Transplantation**
- **Bicaval Transplantation**

Lower-Shumway 1967
Yacoub and Banner 1989

**Heart Transplant Patient**

**Routine Echocardiography**
and Suture Lines in Heart Transplant
ECHOCARDIOGRAPHY OF THE TRANSPLANT PATIENT

• Enlarged Atria: Suture Line
• Increased LV Mass (antirejection medication hypertension)
• RV Enlargement (variable pulmonary hypertension)
• Paradoxical septal motion (exaggerated translation)


MAJOR PROBLEMS TO WATCH FOR IN TRANSPLANT PATIENTS

• Rejection
• Complications of Biopsy
• Allograph Associated CAD

Longitudinal Strain After Transplant

N = 51 transplant recipients

Eleid et al. J Am Coll Cardiol Img 2010;3:989 –1000

DETECTION OF TRANSPLANT REJECTION ENDOMYOCARDIAL BIOPSY

Color-coded tissue Doppler (TD) echocardiography can noninvasively quantify alterations in left ventricular (LV) systolic and diastolic function. The objective of this study was to test the hypothesis that TD may play a role in the detection of LV dysfunction associated with allograft rejection in heart transplant recipients.

METHODS AND RESULTS:
Seventy-eight consecutive transplant recipients underwent 89 TD studies of posterior wall myocardial velocity gradient and mitral annular velocity within 1 hour of endomyocardial biopsy. Color TD echocardiographic images were digitized for semiautomated computer analysis. Histologic analysis revealed no significant rejection in 75 biopsies and significant rejection in 14. TD posterior wall peak systolic and diastolic velocity gradients were reduced significantly with rejection: 3.9 +/- 2.0 (s-1) versus 2.6 +/- 0.9 (s-1) and 5.4 +/- 2.4 (s-1) versus 3.5 +/- 1.6 (s-1), respectively (P < .05 vs the nonrejecting group). Peak systolic and diastolic mitral annular velocities by TD were also reduced with rejection: 63 +/- 14 mm/s versus 49 +/- 12.4 mm/s and 90 +/- 23 mm/s versus 60 +/- 21 mm/s, respectively (P < .001 vs the nonrejecting group). A TD peak-to-peak mitral annular velocity >155 mm/s had 68% sensitivity, 71% specificity, and 88% negative predictive value for detecting rejection. Although TD was unable to discriminate between rejection and other causes of low velocity values, high TD velocity values were supportive of excluding rejection.

ISHLT Classification of Acute Rejection

1985 Revised Classification

Grade 0: Normal
Grade 1A: (mild) Intimal and/or subintimal infiltrate with up to 1 focus of myocardial damage
Grade 2: (moderate) Two or more foci of infiltrate with associated myocardial damage
Grade 3: (severe) Diffuse infiltrate with multifocal myocardial damage; ostia, interventricular, and valvular may be present

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Evaluation of tissue Doppler echocardiography in the detection of allograft rejection in heart transplant recipients.


PEAK DIASTOLIC MITRAL ANNULAR VELOCITY (E’) VS. TRANSPLANT REJECTION GRADE


Tissue Doppler Strain Rate and Strain to Detect Rejection

Speckle Tracking Strain and Transplant Rejection

N = 34 transplant recipients

Torsion and Heart Transplant Rejection

Apical Rotation

Basal Rotation

32 heart tx patients
301 biopsies

Torsion as a Marker of LV Dysfunction in Peds Transplants

32 children with heart transplants
35 children as controls


Echocardiographic Detection of Acute Rejection

- Several small series suggest echo markers of LV dysfunction are associated with rejection (strain, strain rate, torsion).
- LV Dysfunction may occur from cardiac allograft vasculopathy as confounding variable.
- No convincing cut-off values or approach yet exists to incorporate into clinical practice.
- Endomyocardial biopsy remains the clinical standard for rejection surveillance.
- Future prospective studies are still required.

CARDIAC ALLOGRAFT VASCULOPATHY (CAV)

- #1 Cause of death in heart transplant patients
- Diffuse disease – only 10-15% with typical epicardial stenosis.
- Wall motion abnormalities on echo – sometimes atypical distribution.
DSE in Heart Transplant Patients

- 497 consecutive TX pts
- 1,243 DSEs
- Only 20 (4%) positive DSE study.
- Sensitivity = 7%, Specificity = 98% for CAV

Chirakarnjanakorn et al. J Heart Lung Transplant 2015;34:710–717

Stress Echo for “Marginal” Donors

- > 50 yrs
- < 50 years with
  - History of cocaine
  - 3 CV Risk factors: hypertension, diabetes, smoking, history, dyslipidemia.
- Family history of premature coronary artery disease
- Dipyridamole (0.84 mg/kg over 6 min, n = 25) or Dobutamine (up to 40 mg/kg/min, n = 3)
- N = 16 marginal donors transplanted. All normal or nearly normal coronaries at 1 month.


Dobutamine stress echocardiography is inadequate to detect early cardiac allograft vasculopathy

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- 154 transplant recipients with DSE and Coronary Angio
- 29 patients (27%) had CAV on angio: 28 CAV 1 and 1 CAV 2
- Only 1 DSE was positive

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Echocardiographic Detection Cardiac Allograft Vasculopathy

- No clear consensus for use of DSE, although widely used by many centers.
- Recent data suggests the DSE has low sensitivity, but high specificity for CAV.
- Future studies on precise role of DSE and coronary angiography with IVUS is still under development.

Diastolic Function and Survival in Heart Transplant

N = 120 transplant recipients F-U 7 years


Adult Heart Transplants Freedom from Malignancy by Type
(Follow-ups: April 1994 – June 2014)

% Free from Malignancy

- Any Malignancy
- Lymphoma
- Skin
- Other

Adult Heart Transplants % of Patients Bridged with Mechanical Circulatory Support*
(Transplants: January 2000 – December 2013)

% of Patients Year of Transplant

- ECMO
- LVAD+ECMO
- TAH
- LVAD+RVAD
- RVAD
- LVAD

* LVAD, RVAD, TAH, ECMO

CONTINUOUS FLOW LVADs 2016
HeartMate II™
Heartware™
St. Jude Medical
Medtronic

Adult Heart Transplants % of Patients Bridged with Mechanical Circulatory Support* by Year and Device Type

% of Patients Year of Transplant

- ECMO
- LVAD+ECMO
- TAH
- LVAD+RVAD
- RVAD
- LVAD

* LVAD, RVAD, TAH, ECMO
How Are Implant Trends Changing?

Total LVAD Volume by Indication

Bridge to Transplant

Destination Therapy

Clinical Decisions: Transplant vs. LVAD

Transplant

Overlap

Destination therapy

Palliation

Age and Co-morbidities

J. Tueteburg, MD

TAKE HOME MESSAGES

• Echocardiography is the standard of care for follow-up of patients with cardiac transplantation.
• Echo is useful to detect complications of endomyocardial biopsy (tricuspid regurgitation)
• Several small series suggest new echo markers of LV dysfunction are associated with rejection (strain, strain rate, torsion).
• LV Dysfunction may occur from cardiac allograft vasculopathy (CAV).
• DSE is used by many centers for detection of CAV: specificity is high, but sensitivity is low.
• Future prospective studies are still required.