Myocarditis
An update in treatment and management
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Myocarditis

- Definition
- Etiology
- Epidemiology
- Clinical presentations
- Diagnosis
- Treatment
- Outcome and prognosis
Definition

• A process characterized by inflammatory infiltrate of the myocardium with necrosis and/or degeneration of adjacent myocytes not typical of the ischemic damage associated with coronary artery disease.

Etiology

• Infectious:
  Viral
  Bacterial
  Parasitic
  Fungal
  TB
Etiology

• Non-infectious:
  Drugs and toxins
  Autoimmune
  Collagen-vascular diseases
  Idiopathic
Viral Myocarditis

• The most common
• Usually sporadic
• Can be epidemic
Viral Myocarditis

- **1980s:** Coxsackievirus
- **1990s:** Adenovirus
- **2000s:** Parvovirus B19

Breinholt et al, JHLT 2010; Moulik et al, JACC 2010
Epidemiology

- Underdiagnosed
- 9% (Myocarditis Treatment Trial, 1995)
- 4-5% (obtained from young men dying of trauma)
- 16-21% (found in autopsy series of children dying suddenly)
- WHO reported 1-4% of cardiac involvement after enteroviral infection
Clinical presentations

- Seen at all ages
- Presents typically with heart failure
- May present in cardiovascular collapse
- May present with bradycardia and AV Block
- May present with VT or other forms of arrhythmia
- May present with nonspecific symptoms
Diagnosis

- Clinical
- Lab:
  - Viral cultures
  - PCR
  - ECG
  - CXR
  - ECHOCARDIOGRAPHY
  - Biopsy
Echocardiography

– Findings include the following:
  • Global hypokinesis (the most common finding)
  • Increased left ventricular end diastolic and systolic dimensions
  • Left ventricular dysfunction, primarily systolic with decreased ejection fraction and shortening fraction
  • Segmental wall motion abnormalities
  • Pericardial effusion
LVDs 6.38 cm

IVS [LVD] LVPW
Cardiac Biopsy

• Endomyocardial biopsy:
The inflammatory infiltrate is usually patchy and scattered in the ventricular myocardium. Sensitive in 3% to 63% of cases. Chow et al. and Hauck et al reported that to identify 80% of cases 17 or more specimens must be obtained.
• Endomyocardial biopsy:
  Because of the risk of associated with biopsy especially in young children or those with severe ventricular dilation, many centers have abandoned this procedure.
Dallas Criteria

- Active myocarditis
  inflammatory infiltrate+ myocyte degeneration or necrosis
- Borderline myocarditis
  too sparse an infiltrate or no degeneration
- No myocarditis
  no infiltrate and degeneration
Management of myocarditis

- Includes management of:
  - Shock
  - Heart failure and ventricular dysfunction
  - Arrhythmias
  - Specific treatment for certain etiologies (e.g., TB)
Inotropic support

• Low dose dopamine (2-5 mcg/kg/min) to support BP
• Plus phosphodiesterase inhibitor (Milrinone) 0.125- 1 mcg/kg/min to diminish afterload and augment cardiac output
• If more inotropic support needed dobutamine 1-10 mcg/kg/min can be used
• Further afterload reduction may be achieved with sodium nitroprusside 0.3-4 mcg/kg/min provided that BP is maintained.

• Rarely epinephrine or norepinephrine are required.
Diuresis

- IV diuretics are used to augment diuresis and improve congestive symptoms

- Continuous IV Furosemide have been used with success in pediatric patients when intermittent dosing has failed to result in adequate diuresis
If the patient stabilized and there is end-organ perfusion improvement:

• Weaning off milrinone and introduction of ACE inhibitor
• If oral intake tolerated shift all IV to oral Rx
• Digoxin can be started
Rezkalla S. et al. 1990
Proved the beneficial effects of captopril in acute coxcackievirus B3 myocarditis
B-Blockers

• In a multi-institutional experience Shaddy, et al. reviewed the results with metoprolol in 15 children with cardiomyopathy of different etiologies. After a mean of 23 months on metoprolol there was a statistically significant and clinically important increase in EF from 27% to 41%.
• Bruns, et al. reviewed the use of carvedilol in 46 infants and children with cardiomyopathy (80%) or congenital heart disease (20%) at 6 centers. After 3 months of therapy, modified NYHA class improved in 67% of patients and worsened in 11%. Shortening fraction improved slightly, from 16.2% to 19.0%. 
• In a single center study Rusconi, et al. reviewed the results in 24 pediatric patients with dilated cardiomyopathy who received carvedilol. The mean left ventricular ejection fraction improved from 25% to 42%
If No Improvement

• If HF is not responsive to medical management, institution of mechanical circulatory support must be considered.
• ECMO or VAD for short duration or as a bridge to heart transplant.
ECMO and Myocarditis

- Satish K et al, Crit Care Med 2010 Vol. 38, No. 2
- Reviewed the ELSO registry database from 1995-2006
- 19348 (<18y) in 116 centers
- 260 runs for patients with myocarditis (1.3%)
- 61% survival to hospital discharge
- 3% had heart transplant
- In the patients who did not survive:
  arrhythmia, renal failure and female gender found to be associated risk factors.
Other treatment modalities

IVIG:
The use was based on Drucker et al study in 1994.
IVIG in 21/46 children with myocarditis.
Better LV function after 6 months of F/U and less mortality after 1 year.
It did not reach statistical significance due to low volume.
• Systematic review did not show significant improvement with IVIG use based on RCT but some case series and small uncontrolled trial showed improvement of ventricular function.
Steroids and immunosuppression

• The Myocarditis Treatment Trial, 1995: showed no difference among 111 patients treated with azathioprine and prednisone, cyclosporine and prednisone, and conventional therapy.
Interferon

• Kuhl et al, 2003
  Used interferon-B in 22 patients with proven enteroviral or adenovirus infection by PCR with chronic LV dysfunction.
  Given 3x/w for 6 months cleared the virus and improved LV function.
• Daliento et al, 2003
  similar success with alpha interferon in patients with enterovirus myocarditis.
Anticoagulation

• Should be considered to reduce the likelihood of thrombotic/embolic phenomenon especially in more than mild ventricular dysfunction.
Predictors of Outcome

- Foerster, et al, circ heart fail 2010;3:689 found worse outcome associated with:
  - LV FS (P=0.03)
  - LVEDD z-score>2 (P=0.001)
Prognosis

• Poor in newborn with 75% mortality rate in infants with coxsackievirus B.
• Older children have better prognosis with mortality rate between 10-25%
• About 25% of patients will continue to have ECG abnormalities.
Conclusions

• Viral myocarditis can be acute or chronic disorder.
• Treatment of heart failure and ventricular dysfunction is a cornerstone in treatment of myocarditis.
• Despite the frequent use of IVIG and/or steroids, recent clinical experience suggests their use has no impact on outcomes.
Thank You