

The Clinical Utility of E/E' in Atrioventricular Canal Patients Post-Surgical Repair

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Background

Atrioventricular Canal (AVC)

- Congenital malformations of the heart where there is incomplete septation of the four chambers leading to a common atrioventricular (AV) junction and common AV valve.
- Also known as endocardial cushion, or atrioventricular septal defect
- AVC occurs in approximately 1/3800 birth.
- AVC occurs in up to 50% of infants with Down's Syndrome.
- Complete and Partial forms with different anatomical features.
 - Complete (CAVC): ostium primum atrial septal defect (ASD), common AV valve, and inlet ventricular septal defect (VSD)
 - Partial (PAVC): ostium primum ASD, cleft mitral valve without VSD

Conventional Doppler and Tissue Doppler Imaging (TDI)

- Conventional Doppler echocardiography works by computing shifts in machine emitted ultrasound waves when they are reflected by an echo-reflective structure moving in parallel to the waves.
- Conventional Doppler measures velocity changes in blood flow, TDI detects velocity changes in myocardial tissue.
- TDI has become particularly useful in assessing mitral valve function.

Tissue Doppler E/E'

- E/E' is a TDI measurement, also known as E/Ea.
- E/E' is the ratio of E, the inflow velocity across the mitral valve, to E', the myocardial velocity during early diastole detected at the annulus of the mitral valve (also known as Ea).

E/E' and Mitral Valve Function

- E/E' reflects how well left ventricular myocardial tissue is able to relax in diastole.
- In patients without heart defects or disease, E' increases in proportion to E, and the value of the ratio E/E' remains relatively constant at values <8 regardless of cardiac preload.
- In patients with defects or disease, when cardiac preload is increased, E' does not increase as much relative to E. This results in higher E/E' values and can reflect impaired cardiac muscle relaxation in the left ventricle.

E/E' in adult cardiology patients

- An E/E' ratio of ≥ 15 predicts much greater risk for death in adult patients hospitalized for heart failure and acute MI.
- In patients with ventricular conduction delay, such as left bundle branch block, or hemiblock, E/E' has been shown to be an unreliable predictor of LV filling pressure, and hence unreliable indicator of LV diastolic function.

E/E' in pediatric cardiology patients

- The usefulness of E/E' in evaluating pediatric AVC patients post-surgical repair remains unstudied.

Abstract

Introduction: Atrioventricular canal defect (AVC) is the term used to describe potentially life threatening congenital malformations of the heart where there is incomplete septation of the four chambers leading to a common atrioventricular (AV) junction, and a single AV valve. AVC are usefully categorized into partial (PAVC) and complete (CAVC) defects. While the echocardiographic tissue Doppler measurement, E/E', has demonstrated predictive power for mortality in adults with major cardiac disease, its usefulness in evaluating pediatric patients post-surgical repair of AVC remains unstudied. From clinical follow-up it appears that E/E' may not correlate to long-term post-operative prognosis in AVC patients. This study will determine the validity of E/E' in assessing the success of AVC repair, and in quantifying post-surgical well being in AVC patients. Our hypothesis is that E/E' is factitiously elevated in asymptomatic pediatric patients post-surgical AVC repair.

Method: Ninety-three post-operative records for AVC outpatients were obtained from echocardiography and EMR. Data was stored and analyzed on a secure server. Twenty-one outpatients who had E/E' measured were studied. Included patients were described as clinically well, with no remaining evidence of septal defects or shunting at the time of study. Mean patients age was seven years (range, 1-15), and mean interval between surgical correction and echo study was four years (range, <1 to 12). We divided patients into two groups for analysis by AVC type: partial (PAVC) (6) or complete (CAVC) (15). We recorded mean values for E/E' for both the lateral and medial LV basal myocardial tissue for the groups.

Results/Conclusion: Mean lateral E/E' (+/-SD) for 15 CAVC and 6 PAVC patients was 9.7 (+/-2.2) and 8.2 (+/-2.3), respectively. Mean medial E/E' (+/-SD) for CAVC and PAVC patients was 15.0 (+/-4.9) and 12.1 (+/-5.0), respectively. We found that lateral E/E' was consistently lower than medial E/E' for both CAVC and PAVC groups. Medial E/E' in otherwise healthy pediatric CAVC patients was elevated to values that, in post-MI adults, indicate diastolic dysfunction and predict major cardiac events. E/E' in AVC patients lacks clinical relevance especially for medial wall motion. Relative fixation of the crux of the heart may induce this abnormal measure and requires further study.

Method

- Ninety-three post-operative records for AVC outpatients were obtained from echocardiography and EMR.
- Data was stored and analyzed on a secure server.
- Twenty-one outpatients who had E/E' measured were studied.
- We did not include any unbalanced or transitional AVC patients.
- Included patients were described as clinically well, with no remaining evidence of septal defects or shunting at the time of study.
- Two patients with 2+ or higher mitral regurgitation were not included.
- Mean patients age was seven years (range, 1-15), and mean interval between surgical correction and echo study was four years (range, <1 to 12).
- We divided patients into two groups for analysis by AVC type: partial (PAVC) (6) or complete (CAVC) (15).
- We recorded mean values for E/E' for both the lateral and medial LV basal myocardial tissue for the groups.

Hypothesis

E/E' may be factitiously elevated in asymptomatic pediatric patients post-surgical AVC repair.

Results

Mean lateral E/E' (+/-SD) for 15 CAVC and 6 PAVC patients was 9.7 (+/-2.2) and 8.2 (+/-2.3), respectively. Mean medial E/E' (+/-SD) for CAVC and PAVC patients was 15.0 (+/-4.9) and 12.1 (+/-5.0), respectively. We found that lateral E/E' was consistently lower than medial E/E' for both CAVC and PAVC groups.

Table 1. Mean Mitral Valve TDI Values \pm Standard Deviations for Complete and Partial AVC Patients.

AVC Type	Mean Medial E/E'	Mean Lateral E/E'	p value Medial versus Lateral E/E'	Mean E (m/s)	Mean Medial E' (m/s)	Mean Lateral E' (m/s)
Complete (n=15)	15.0 \pm 4.9	9.7 \pm 2.2	0.001	1.23 \pm 0.24	0.09 \pm 0.02	0.13 \pm 0.02
Partial (n=6)	12.1 \pm 5.0	8.2 \pm 2.3	0.026	1.14 \pm 0.23	0.10 \pm 0.03	0.15 \pm 0.03

Discussion/Conclusions

Medial E/E' in otherwise healthy pediatric CAVC patients was elevated to values that, in post-MI adults, would indicate diastolic dysfunction and predict major cardiac events. E/E' in AVC patients may therefore lack clinical relevance especially for medial wall motion. We observed that medial E/E' is significantly higher than lateral E/E' in both Complete and Partial AVC cohorts. Relative fixation of the crux of the heart after surgery, or some inherent difference in AVC myocardial tissue anatomy may induce elevation in medial E in addition to E' depression and requires further study.

We expected to find that an elevation in E, without a corresponding increase in E' in AVC patients post-surgical repair, would contribute to an overall elevation in E/E'. In a subsequent analysis we compared E, E', and E/E' values from AVC patients to those of a cohort of age-matched normals (n=21). We found that Complete AVC patients experience not only a significant elevation in E relative to normals (p=0.005), but also significant depression in E' relative to normals (p=8x10⁻¹¹). Partial AVC patients experience no significant change in E relative to normals (p=0.135), but they do experience significant depression in E' relative to normals (p=3x10⁻⁵). This may suggest that elevation in E/E' in AVC patients is not only due to an elevation in mitral inflow velocity, but also to a decrease in myocardial tissue velocity as a result of surgical repair, or perhaps due to inherent anatomical differences in myocardial tissue contractility in patients born with AVC. Comparing AVC patient tissue Doppler data pre and post surgical repair would help to make this distinction and warrants further study. It has been shown that E/E' is an unreliable measure of LV diastolic function in adult patients with ventricular conductance delay. Elevated E/E' in AVC patients may be due to the left anterior hemiblock pattern often in these patients post-surgical repair.

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