

Exploring Myocardial Function in Adolescent Type 1 Diabetes



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RESULTS

Table 1: Anthropometric Measurements

	T1D n=199	Controls n=178	p value
Sex, M:F	98:101	84:94	0.3759
Age, years	14.4±1.6	14.4±2.1	0.7999
Height, cm	163±10	162±11	0.2477
Weight, kg	60.7±13.3	54.7±13.8	<0.0001
BSA, m ²	1.65±0.22	1.57±0.23	0.0006
BMI, kg/m ²	22.6±4.3	20.6±3.7	<0.0001
SBP, mmHg	113±10	110±9	0.0005
DBP, mmHg	62±7	58±7	<0.0001
MBP, mmHg	77±7	75±7	0.0053
PP, mmHg	51±9	52±8	0.4771
HR, bpm	68±9	68±12	0.0357

BSA=body surface area, BMI = Body Mass Index, SBP =systolic blood pressure; DBP = diastolic blood pressure; MBP=mean blood pressure, PP=pulse pressure, HR=heart rate

Table 2: Tissue Doppler imaging.

	T1D n=199	Controls n=178	p value
TMVE', cm/s	17.6±2.6	18.6±2.6	0.0001
TMVA', cm/s	5.4±1.1	5.9±1.5	0.0001
TMVS', cm/s	10.5±1.8	11.1±2.0	0.0023
MVE/TMVE'	5.8±1.1	5.4±1.0	0.0003
TIVSE', cm/s	13.8±1.8	15.1±2.2	<0.0001
TIVSA', cm/s	5.8±1.0	5.9±1.3	0.0033
TIVSS', cm/s	8.3±0.9	8.6±0.9	0.0140
MVE/TIVSE'	7.3±1.2	6.7±1.3	<0.0001
TTVE', cm/s	13.8±2.4	15.3±2.5	<0.0001
TTVA', cm/s	8.1±2.3	8.1±2.5	0.9164
TTVS', cm/s	12.5±1.6	12.9±1.8	0.0210
TVE/TIVSE'	3.9±0.9	3.9±0.9	0.6200

TMVE'=tissue mitral valve E' velocity, TMVA'=tissue mitral valve A' velocity, TMVS'=tissue mitral valve S' velocity, MVE/TMVE'=mitral valve pulse Doppler E velocity/ mitral valve tissue E' velocity, TIVSE'=tissue interventricular septal E' velocity, TIVSA'=tissue interventricular septal A' velocity, TIVSS'=tissue interventricular septal S' velocity, MVE/TIVSE'=mitral valve pulse Doppler E velocity/ tissue interventricular septal E' velocity, TVE=tissue tricuspid valve E' velocity, TTV=tricuspid valve A' velocity, TTVS=tissue tricuspid valve S' velocity, TVE/TTVE'=tricuspid valve pulse Doppler E velocity/ tissue tricuspid valve E' velocity.

Table 3: Strain and strain rate imaging

	T1D n=199	Controls n=178	p value
MCS, %	-20.4±2.3	-19.5±1.7	<0.0001
GLS, %	-19.0±1.9	-19.8±1.5	<0.0001
GLSRs, %	-1.03±0.15	-1.02±0.15	0.5806
GLSRd, %	1.65±0.31	1.70±0.32	0.3258
Basal Rotation, deg	-4.24±2.41	-4.18±2.00	0.8042
Apical Rotation, deg	6.23±2.95	5.42±2.48	0.0075
Torsion, deg	10.41±3.60	9.55±3.01	0.0203

MCS=mid circumferential strain, GLS=global longitudinal strain, GLSRs=global longitudinal strain rate systolic, GLSRd=global longitudinal strain rate diastolic.

Table 4: Anthropometric Measurements

	Low-Risk n=68	Medium-Risk n=78	High-Risk n=53	Controls n=65
Sex, M:F	27:41	45:33	26:27	28:37
Age, years	14.6±1.6	14.0±1.7	14.7±1.6*	14.0±2.0
Height, cm	165±8	162±11	164±11	162±12
Weight, kg	62.7±13.2**	59.9±16.0*	59.7±12.6*	53.9±12.5
BSA, m ²	1.68±0.19**	1.63±0.24	1.64±0.21*	1.56±0.21
BMI, kg/m ²	23.0±4.2**	22.4±4.8*	22.1±3.7*	20.4±3.8
SBP, mmHg	113±9	113±11	114±9	111±8
DBP, mmHg	62±6	62±7	62±7	62±7
MBP, mmHg	77±6	78±8	78±7	77±7
PP, mmHg	51±8	51±10	52±9	49±6
HR, bpm	67±9	65±9	65±9	67±10

*p<0.05 vs. controls, **p<0.001 vs. controls
BSA=body surface area, BMI = Body Mass Index, SBP =systolic blood pressure; DBP = diastolic blood pressure; MBP=mean blood pressure, PP=pulse pressure, HR=heart rate

Table 5: Tissue Doppler imaging

	Low-Risk n=68	Medium-Risk n=78	High-Risk n=53	Controls n=65
TMVE', cm/s	18.0±2.4	17.2±2.5	17.5±2.9	17.7±2.8
TMVA', cm/s	5.5±1.2	5.4±1.2	5.2±1.0	5.4±1.2
TMVS', cm/s	10.6±1.8	10.5±1.8	10.4±1.7	10.7±2.0
MVE/TMVE'	5.6±1.0	5.9±1.1	5.8±1.2	5.7±1.0
TIVSE', cm/s	13.8±1.6	13.9±2.0	14.0±1.8	14.4±2.2
TIVSA', cm/s	5.6±0.9	5.6±1.1	5.4±1.0	5.4±1.0
TIVSS', cm/s	8.3±0.8	8.4±0.9	8.2±1.0	8.5±0.9
MVE/TIVSE'	7.2±1.0	7.3±1.3	7.3±1.4	7.0±1.3
TTVE', cm/s	14.0±2.2	13.9±2.5	14.0±2.6	14.7±2.4
TTVA', cm/s	8.4±2.2*	7.9±2.2	8.2±2.4*	7.4±2.2
TTVS', cm/s	12.6±1.6	12.4±1.8	12.4±1.5	12.9±1.8
TVE/TIVSE'	3.9±0.8	3.9±0.8	4.0±1.0	4.1±0.9

*p<0.05 compared with controls
TMVE'=tissue mitral valve E' velocity, TMVA'=tissue mitral valve A' velocity, TMVS'=tissue mitral valve S' velocity, MVE/TMVE'=mitral valve pulse Doppler E velocity/ mitral valve tissue E' velocity, TIVSE'=tissue interventricular septal E' velocity, TIVSA'=tissue interventricular septal A' velocity, TIVSS'=tissue interventricular septal S' velocity, MVE/TIVSE'=mitral valve pulse Doppler E velocity/ tissue interventricular septal E' velocity, TVE=tissue tricuspid valve E' velocity, TTV=tricuspid valve A' velocity, TTVS=tissue tricuspid valve S' velocity, TVE/TTVE'=tricuspid valve pulse Doppler E velocity/ tissue tricuspid valve E' velocity.

Table 6: Strain and strain rate imaging

	Low-Risk n=68	Medium-Risk n=78	High-Risk n=53	Controls n=65
MCS, %	-20.4±2.6	-20.7±2.1	-20.2±2.2	-20.5±1.3
GLS, %	-19.1±2.0*	-18.9±1.7**	-19.0±2.0*	-20.1±1.1
GLSRs, %	-1.03±0.15	-1.03±0.14	-1.03±0.15	-1.02±0.15
GLSRd, %	1.63±0.32	1.64±0.29	1.70±0.32	1.70±0.32
Basal Rotation, deg	-4.40±2.51	-4.22±2.49	-4.08±2.22	-4.41±1.95
Apical Rotation, deg	6.44±3.24	6.07±2.61	6.15±3.04	6.13±2.75
Torsion, deg	10.8±3.81	10.11±3.60	10.23±3.32	10.29±3.04

*p<0.001 vs. controls, **p<0.0001 vs. controls
MCS=mid circumferential strain, GLS=global longitudinal strain, GLSRs=global longitudinal strain rate systolic, GLSRd=global longitudinal strain rate diastolic.

Table 7: Clinical and Laboratory Measurements

	Low-Risk n=68	Medium-Risk n=78	High-Risk n=53	Controls n=65
T1D duration, years	8.0±3.4	6.9±3.0	6.7±2.9	-
Glucose, mmol/L	8.5±3.5**	10.5±4.8**	10.1±4.5**	4.7±0.7
HbA1c, %	0.084±0.012**	0.085±0.013**	0.086±0.013**	0.054±0.002
Cholesterol, mmol/L	4.35±0.85	4.36±0.97	4.24±0.77	4.24±0.83
HDL, mmol/L	1.66±0.40*	1.61±0.33*	1.65±0.34*	1.46±0.28
LDL, mmol/L	2.32±0.72	2.36±0.77	2.20±0.60	2.36±0.74
Triglycerides, mmol/L	0.83±0.35	0.85±0.41	0.84±0.32	0.93±0.40
Creatinine, mmol/L	55±9	53±9	53±10	56±11
GFR, mL/min/1.73 m ²	111±17	114±17	115±18*	108±17

*p<0.05 vs. controls, **p<0.0001 vs. controls
T1D duration=type 1 diabetes duration, HbA1c=haemoglobin A1c, LDL=low-density lipoprotein cholesterol, HDL=high-density lipoprotein cholesterol, GFR=glomerular filtration rate

INTRODUCTION

Preclinical detection of myocardial dysfunction in adolescents with type 1 diabetes (T1D) may help identify individuals at increased risk of adult-onset cardiovascular disease, who would most benefit from early intervention strategies. This study compared echocardiographic assessment of myocardial function in patients screened for the Adolescent Type 1 Diabetes Cardio-renal Intervention Trial (AdDIT) with healthy controls.

METHODS

Study Design

Single center prospective cross-sectional study

Patient Population

The AdDIT study is a multi-centre, randomized, double-blind, placebo-controlled, 2x2 factorial design trial of angiotensin-converting enzyme inhibitor and statin therapy vs. placebo in 500 high-risk (>1.2 mg/mmol) T1D adolescents, defined on the basis of albumin excretion.¹ It also includes a parallel observational study based on longitudinal follow-up of 400 low-risk (<0.8 mg/mmol) and medium-risk (0.8-1.2 mg/mmol) T1D adolescents who were screened but did not qualify for randomization. Subjects recruited in the current study were low- and medium-risk from the parallel observational study and high-risk T1D adolescents that declined participation in the randomized controlled trial. All 199 T1D were compared with 178 adolescents recruited as healthy volunteers, who were not on any vasoactive medications, had no previous history of familial hyperlipidemia, diabetes, obesity, hypertension, or any other significant cardiac, renal or systemic disease and normal cardiac anatomy and function by screening echocardiogram. In subgroup analysis, 68 low-, 78 medium- and 53 high-risk were compared with 65 controls that underwent the same baseline clinical assessment.

Anthropometric Assessment

Height was measured by stadiometer to the nearest 0.1 cm and weight by electronic balance to the nearest 0.1 kg. Resting heart rate and right brachial blood pressure was measured using an age-appropriate cuff and averaging 3 readings with an automated DINAMAP® sphygmomanometer (Criticom, Tampa, Florida, USA).

Echocardiographic Assessment

Using a Vivid 7 ultrasound system (GE, General Electric Corp., Wisconsin, USA) with appropriate transducers ranging from frequencies 4-12 MHz depending on subject age and size, a standardized functional imaging protocol, including parasternal and apical views, was performed according to published guidelines.² Myocardial function assessment included tissue Doppler, strain and strain rate imaging.

Laboratory Assessment

Glycemic control was measured by fasting blood glucose and haemoglobin A1c. Serum lipids including total, low-density lipoprotein and high-density lipoprotein cholesterol and triglycerides were measured. Serum creatinine was used to estimate glomerular filtration rate.³

Statistical Analysis

Between groups comparisons were performed using Student's t-tests. Relationships were tested using Pearson's correlations. Statistical significance was considered at p<0.05.

References

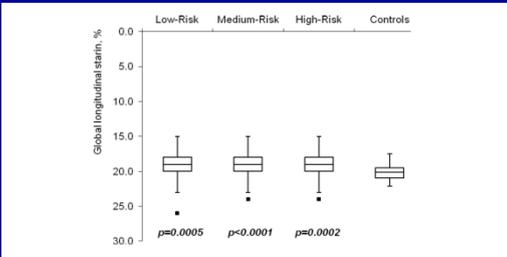
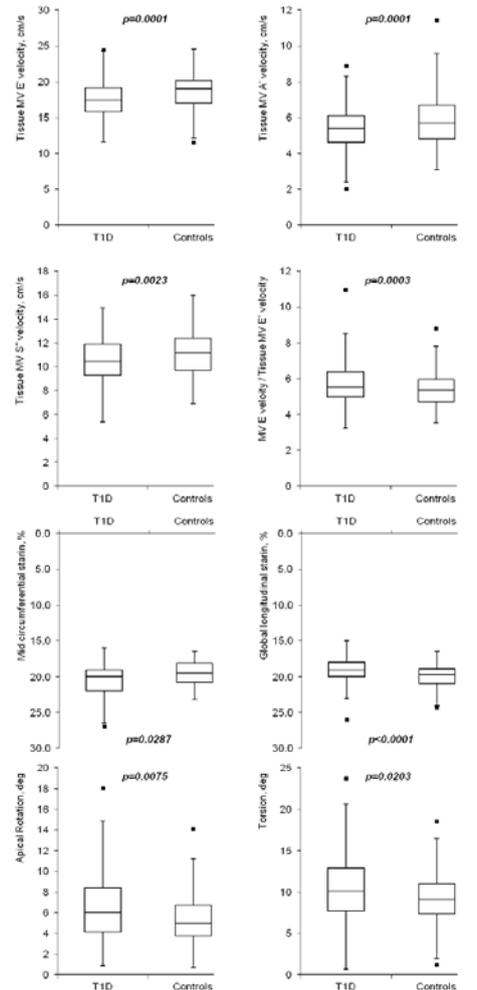
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CONCLUSIONS

Significant changes in myocardial function are evident in adolescent T1D of short to intermediate disease duration, suggesting these may be clinically useful preclinical markers of deterioration in cardiac performance to guide early intervention.

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Pearson's correlations

Significant positive correlations: tissue MV A' with BMI for medium- and high-risk T1D and controls; global longitudinal strain with BMI for controls.

Variable	Low-Risk	Medium-Risk	High-Risk	Controls
TMVE : BMI	r=+0.00 p=0.9698	r=-0.02 p=0.0827	r=+0.22 p=0.1070	r=-0.01 p=0.8551
TMVA : BMI	r=-0.07 p=0.5435	r=+0.23 p=0.0473	r=+0.30 p=0.0297	r=+0.15 p=0.0443
GLS : BMI	r=+0.23 p=0.0752	r=+0.03 p=0.7744	r=+0.10 p=0.4681	r=+0.25 p=0.0014
Torsion : BMI	r=-0.10 p=0.4296	r=+0.21 p=0.0971	r=+0.03 p=0.8256	r=+0.02 p=0.8427
TMVE : HbA1c	r=+0.02 p=0.8494	r=-0.01 p=0.9068	r=-0.14 p=0.3108	r=+0.05 p=0.6887
TMVA : HbA1c	r=+0.07 p=0.5542	r=+0.10 p=0.3671	r=+0.15 p=0.2930	r=+0.14 p=0.2743
GLS : HbA1c	r=+0.14 p=0.2856	r=-0.12 p=0.3159	r=+0.11 p=0.4339	r=-0.11 p=0.4084
Torsion : HbA1c	r=+0.00 p=0.9795	r=-0.12 p=0.3336	r=+0.13 p=0.3697	r=+0.11 p=0.4221