Cardiac Remodeling In Young Adult Tennis Players

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Introduction

- Cardiac remodeling consists of adaptive responses of the heart to a prolonged excessive physiological load or pathological stress
- Tennis players often engage in high-intensity drills and competitions
- Prolonged, intense endurance exercise can lead to increased stretching of the atrial muscle wall. The stretching potentially can result in irreversible cardiac remodeling, and therefore increases the risk of arrhythmias
- Currently, knowledge regarding cardiac remodeling in young tennis athletes remains sparse
- This study investigates cardiac remodeling in young tennis players

Methods

- Recruitment of 14 male college tennis players (with at least 3 years of experience, average age 8.3 ± 3.8 years, tennis group "Tennis") and 6 non-tennis college students (control group "Controls").
- Venous blood sampling, including tests for hematocrit, N-terminal pro B-type natriuretic peptide (NT-pro BNP), and creatine kinase (CPK) levels.
- Each participants completed the Cooper 12-minute run test for the calculation of VO_2 max using the formula: VO_2 max = (22.351 x kilometers) - 11.288 to obtain maximal oxygen consumption (VO_2 max) data.
- A comprehensive measurement of heart dimensions and function using real-time 3D echocardiography.

Results

Table 1. Demographics, VO_2 max, and laboratory data

Items	Controls (n=6)	Tennis (n=14)	P value
Age (years)	20.9 ± 3.0	22.5 ± 4.4	0.35614
Height (cm)	171.5 ± 5.60	175.4 ± 3.4	0.16172
Body weight (kg)	63.2 ± 8.4	68.8 ± 6.3	0.18378
Waist circumference (cm)	78.3 ± 8.8	79.8 ± 5.1	0.71668
Hip circumference (cm)	98.5 ± 9.0	98.5 ± 4.5	0.99295
Systolic BP (mmHg)	140.2 ± 8.7	130.9 ± 9.0	0.05697
Diastolic BP (mmHg)	83.3 ± 6.8	82.7 ± 8.8	0.86719
Pulse rate (beats/min)	86.8 ± 12.7	70.9 ± 7.0	0.02605
VO_2 max (mL/kg/min)	32.9 ± 6.9	43.4 ± 3.8	0.01129
12-minute run (meters)	1977.5 ± 306.1	2446.4 ± 169.4	0.01128
Laboratory data			
Hematocrit (%)	46.7 ± 2.3	45.6 ± 2.8	0.36496
NT-pro BNP (pg/mL)	17.8 ± 6.1	21.7 ± 11.0	0.53761
CPK (IU/L)	146.3 ± 61.1	182.5 ± 202.2	0.55137

*All values are expressed as Mean ± SD.
BP, blood pressure; VO_2 max, maximal oxygen uptake; 12 min run, maximum distances that participants can run in 12 minutes; BNP, brain natriuretic peptide; CPK, Creatine-phospho-kinase.

Table 2. Dimensional measurements in the echocardiography

Items	Controls (n=6)	Tennis (n=14)	P value
Aorta (cm)	3.18 ± 0.26	3.15 ± 0.33	0.81389
Left Ventricle (LV)			
IVSd (cm)	0.86 ± 0.10	0.93 ± 0.11	0.22136
LVIDd (cm)	4.90 ± 0.29	5.01 ± 0.39	0.51585
LVIDs (cm)	3.03 ± 0.18	3.16 ± 0.28	0.21434
LVPWd (cm)	0.81 ± 0.04	0.90 ± 0.06	0.00080
LVPWs (cm)	1.55 ± 0.18	1.56 ± 0.16	0.88671
LV mass (g/m^2)	79.38 ± 7.65	88.66 ± 14.78	0.08297
FS (%)	38.22 ± 3.26	36.82 ± 3.63	0.41555
LVEDV (mL)	134.83 ± 20.31	142.43 ± 15.37	0.43682
LVESV (mL)	56.83 ± 13.83	55.21 ± 10.39	0.80386
LVEF (%)	58.17 ± 5.19	61.57 ± 4.86	0.20421
Right Ventricle (RV)			
FAC (%)	38.78 ± 4.66	40.72 ± 7.25	0.49449
TAPSE (mm)	10.80 ± 5.20	11.78 ± 10.39	0.78819
RVEDV (mL)	110.05 ± 21.92	142.34 ± 17.34	0.01292
RVESV (mL)	62.70 ± 12.58	76.26 ± 12.44	0.05246
RVEF (%)	42.87 ± 3.66	46.70 ± 5.74	0.09423
Left Atrium (LA)			
LA Diameter (cm)	3.15 ± 0.34	3.46 ± 0.49	0.12204
LA Volume (mL)	36.07 ± 5.97	49.36 ± 10.80	0.00276
LA Volume Index (ml/m^2)	20.85 ± 2.91	26.93 ± 5.51	0.00518
LAEF (%)	66.50 ± 9.41	61.57 ± 9.21	0.25300

*All values are expressed as Mean ± SD.
IVSd, interventricular septum thickness at end-diastole; LVIDs, Left ventricular internal diameter at end-systole; LVIDd, Left ventricular internal diameter at end-diastole; LVPWs, left ventricular posterior wall thickness end-systole; LVPWd, left ventricular posterior wall thickness end-diastole; LV mass, derived by cube (Teichholz) formula; FS, fractional shortening; LVESV, left ventricular end-systolic volume; LVEDV, left ventricular end-diastolic volume; LVEF, left ventricle ejection fraction; RVESV, right ventricular end-systolic volume; RVEDV, right ventricular end-diastolic volume; FAC, fractional area change; TAPSE, tricuspid annular plane systolic excursion; LAEF, left atrial emptying fraction.

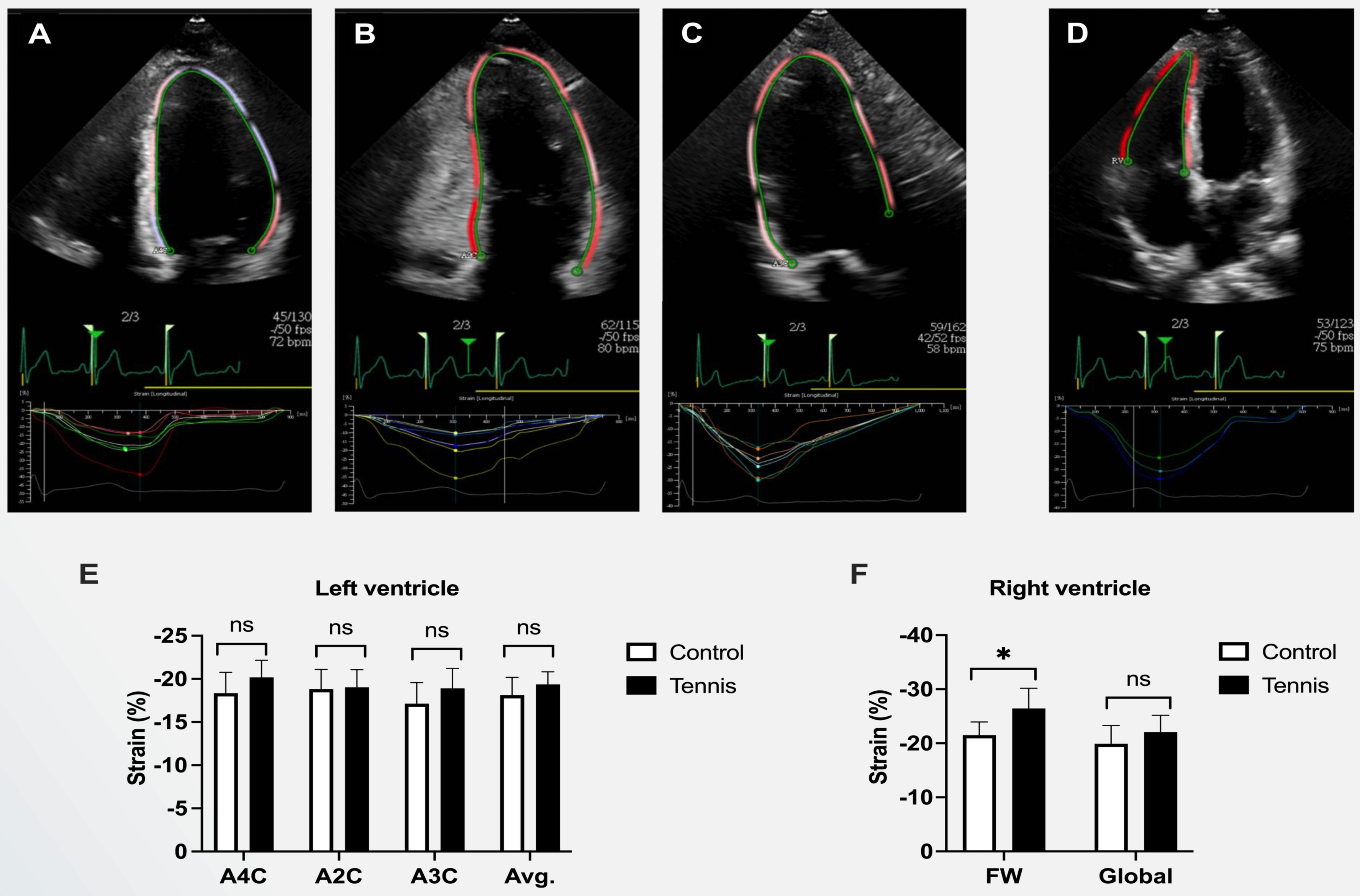

Figure 1. Longitudinal strain of left and right ventricles and analysis. Left ventricle global longitudinal strain analysis in A4C view (**A**), A2C view (**B**), and A3C view (**C**). The RV free wall longitudinal strain analysis in the RV-focused 4-chamber view (**D**). There is no difference between two groups for the LV longitudinal strain (**E**). The Tennis group has larger RV strain for the free wall (FW)(**F**).

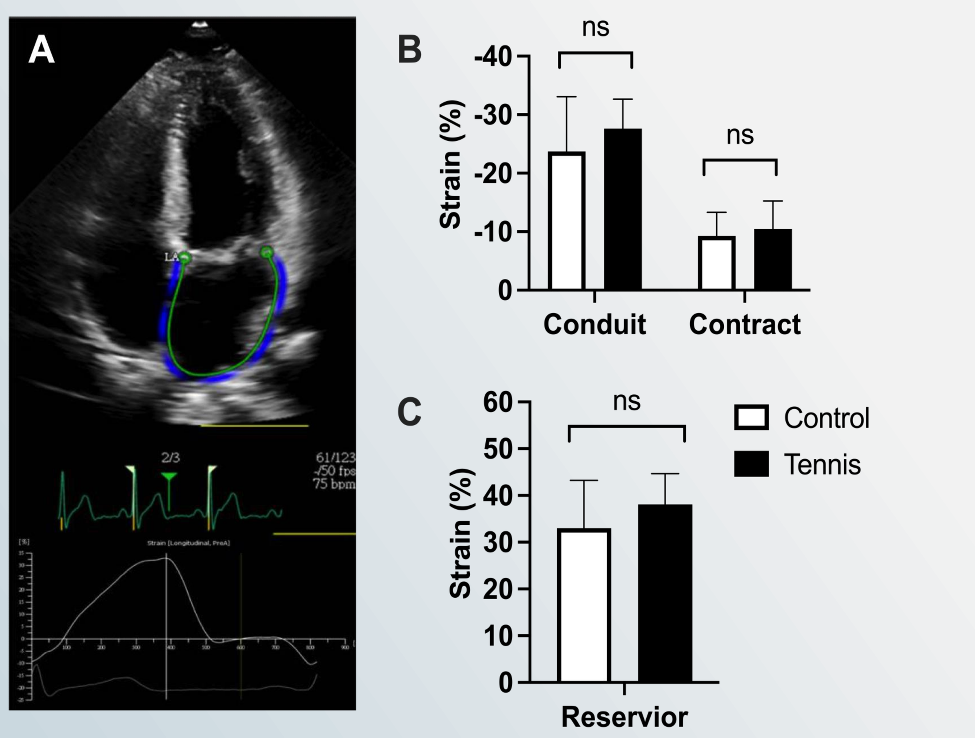

Figure 2. Longitudinal strain of left atrium. **A.** Representative LA strain acquiring image. **B.** Analysis results for the conduit, contraction, and **C.** the reservoir strain of LA.

Tennis playing in non-professional, young male adults

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↑ Left ventricle post. wall
↑ Left atrial volume
↑ Right ventricle volume
↑ RV compliance

↓

↑ Max. oxygen consumption

Conclusions

- In young adults, tennis drills leads to significant cardiac remodeling, with increase of left atrial volume, right ventricular volume, and left ventricular posterior wall thickness.
- The left atrial and left ventricular function are unchanged.
- The enhanced right ventricular strain can contribute to the increased VO_2 max (maximal oxygen consumption) in young tennis players.
- The dilated left atrium has preserved strain.
- The results suggest that tennis drills do not induce any adverse cardiac remodeling in young players.

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