


Assessment of the physical performance in children with preexcitation syndrome, before and after catheter ablation of the accessory pathway: A pilot study

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Recently more interest has been given to the phenomenon of dyssynchrony of ventricular activation caused by the fusion of the intrinsic and antegrade conduction via the accessory pathway in patients with preexcitation syndrome. It has been noted that septal and right sided pathways were proven to have the main impact on the left ventricle dyssynchrony and causing dilated cardiomyopathy that can be reversible with either pharmacological or catheter ablation [1–9]. The aim of this study was to assess whether in children diagnosed with preexcitation syndrome, the key physical performance parameters assessed with the cardio-pulmonary exercise test (CPET) improves following successful catheter ablation of the accessory pathway.

The study group consisted of 14 children, 11 boys and 3 girls aged 8–16 years (12.7 mean), diagnosed with preexcitation syndrome, both symptomatic and asymptomatic patients, who were referred to our department for electrophysiologic (EP) study and ablation. All patients underwent routine assessment with 12-lead-electrocardiogram (ECG), 24-hour Holter ECG and echocardiography. Only patients with no associated cardiac anomalies were included into the study. A CPET according to the RAMP15 protocol was performed before and 3–4 months after the ablation.

Patients in the study group were examined using EPIQ ultrasound system (Philips). Standard pro-

tolocol was used with routine measurements according to clinical practice and international guidelines.

The CPET was performed using the upright sitting cycle-ergometer according to the RAMP15 protocol. 12-lead-ECG was recorded and analyzed throughout the entire test and behavior of the delta wave was observed. Breath-by-breath measurement of the oxygen uptake (VO_2) and carbon dioxide (VCO_2) elimination was performed continuously together with respiratory exchange ratio (RER). To calculate the VO_{2max} , measurement at the VO_2 plateau during maximal exercise was used, alternatively the maximal VO_2 value at the peak exercise if the plateau was not observed. The oxygen pulse (O_2 -pulse) was calculated by dividing VO_2 by heart rate measured at any point and then at the maximal exercise. Anaerobic threshold was calculated by the V-slope method. Workload expressed in Watts was recorded at the peak of exercise. Patients were verbally encouraged to continue the effort with voluntary termination at the patient's exhaustion.

Patients were qualified for the invasive treatment based on the clinical assessment and parent's/patient's decision only. All patients underwent invasive EP study and radiofrequency-ablation under general anaesthesia, using three-dimensional-mapping system (CARTO). Only patients with successful removal of the accessory pathway (AP) were included into the study.

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Table 1. Comparison of the cardio-pulmonary exercise test (CPET) and echocardiography results before and after the accessory pathway ablation.

	Group	M	SD	95% CI		t	p	Cohen's d
				LL	UL			
CPET parameters								
VO ₂ max [mL/kg/min]	Before	36.25	8.08	32.02	40.48	1.60	0.134	0.44
	After	38.45	7.61	34.46	42.44			
VO ₂ max [L/min]	Before	2.05	0.51	1.77	2.32	2.89	0.013*	0.84
	After	2.28	0.62	1.95	2.62			
RQ (RER)	Before	1.09	0.08	1.05	1.13	0.57	0.579	0.16
	After	1.10	0.09	1.05	1.15			
VE/VCO ₂	Before	26.17	4.31	23.92	28.43	1.46	0.169	0.4
	After	27.14	3.73	25.18	29.09			
O ₂ pulse [mL/beat]	Before	10.92	3.21	9.24	12.60	3.74	0.002*	1.04
	After	12.46	3.74	10.51	14.42			
Workload [watt]	Before	143.57	45.84	119.56	167.59	4.18	0.001*	1.16
	After	163.93	42.21	141.82	186.04			
VO ₂ /Work [mL/min/watt]	Before	11.17	1.46	10.40	11.94	0.60	0.558	0.17
	After	11.47	1.21	10.84	12.10			
Time [s]	Before	572.00	177.80	478.86	665.14	1.95	0.073	0.54
	After	621.07	166.37	533.93	708.22			
AT [mL/kg/min]	Before	18.12	4.39	15.63	20.60	0.70	0.501	0.21
	After	18.89	3.25	17.05	20.73			
AT [L/min]	Before	1.01	0.33	0.83	1.19	0.80	0.437	0.23
	After	1.06	0.24	0.94	1.19			
HR at peak effort [bpm]	Before	180.07	21.54	168.79	191.36	0.40	0.696	0.11
	After	182.14	9.69	177.06	187.22			
BP systolic at peak effort [mmHg]	Before	159.00	16.80	150.20	167.80	1.28	0.224	0.35
	After	165.43	16.69	156.69	174.17			
BP diastolic at peak effort [mmHg]	Before	70.23	19.22	59.78	80.68	-1.63	0.129	0.47
	After	58.23	13.58	50.85	65.61			
Echocardiography parameters								
RVIDd [mm]	Before	18.50	3.32	16.76	20.24	0.04	0.969	0.01
	After	18.53	3.49	16.70	20.36			
IVSd [mm]	Before	7.15	1.59	6.28	8.01	1.05	0.312	0.30
	After	7.42	1.68	6.50	8.33			
LVIDd [mm]	Before	47.80	4.87	45.25	50.35	-0.85	0.412	0.24
	After	47.25	4.43	44.93	49.57			
EF [%]	Before	70.84	4.78	68.33	73.34	-0.99	0.340	0.27
	After	69.21	3.51	67.37	71.05			
SF [%]	Before	39.15	2.85	37.60	40.70	-0.52	0.611	0.15
	After							

VO₂max — oxygen consumption at the peak of exercise; RQ (RER) — respiratory exchange ratio; VE — minute ventilation; VCO₂ — carbon dioxide output; AT — VO₂ at anaerobic threshold; HR — heart rate; BP — blood pressure; RVIDd — right ventricular internal dimension in diastole; IVSd — interventricular septal thickness at diastole; LVIDd — left ventricular internal dimension in diastole; EF — ejection fraction; SF — shortening fraction; n — count; M — mean; SD — standard deviation; 95% CI — 95% confidence interval; LL — lower limit; UL — upper limit; t — t-test statistic; p — p value; Cohen's d — effect size coefficient; *results with p value < 0.05

To examine the differences in the values of dependent variables between groups containing patients before and after ablation multiple t-Student tests for dependent samples were performed. Only complete cases for each continuous variable were chosen and then the normality assumption was checked using skewness values. For each group mean (M), standard deviation (SD), 95% confidence intervals (95% CI) with lower (LL) and upper (UL) limits were shown. As the effect size coefficient Cohen's d was used. The global significance level was $\alpha = 0.05$.

The echocardiography for all patients in the study group showed a normal heart structure, normal left ventricular size, and function within normal values. There were no statistically significant differences in echocardiographic measurements before and after the ablation procedure.

All patients both before and after the ablation achieved maximal effort, with RER ≥ 1.0 during the CPET with no differences regarding maximal heart rate (HR), systolic and diastolic, blood pressure, exercise time, anaerobic threshold, VO_2 /work and VE/ CO_2 ratios. After the ablation patients showed significantly higher values of O_2 -pulse ($p = 0.002$), total VO_2 max (L/min) with $p = 0.013$ and achieved higher workload during exercise ($p = 0.001$). The measurement of the VO_2 max expressed in mL/kg/min did not differ significantly.

Results are shown in Table 1.

The present study shows that children with preexcitation syndrome improved the key parameters describing the physical performance following the successful catheter ablation of the accessory pathway. Following the ablation patients achieved higher VO_2 max, O_2 -pulse and workload during the exercise. The total VO_2 measurement improved however while expressed with relation to the body weight, failed to differ significantly. That could be an effect of a small study group, or body weight may play a role in VO_2 measurement. Exercise time was longer after the ablation, which correlates with higher workload, however it failed to differ statistically ($p = 0.07$; Cohen's d = 0.54), likely an effect of a small study group.

VO_2 max is described by a Fick equation as a result of the cardiac output (CO) and maximal arterio-venous oxygen difference: $VO_2 = CO \times (a-v)O_2$. As the oxygen extraction is not affected in patients with cardiovascular problems, VO_2 max mostly depends on the CO. O_2 -pulse is the ratio between the VO_2 and HR, and it is a measure of the stroke volume (SV) during the exercise:

$$VO_2 = CO \times (a-v)O_2 = (SV \times HR) \times (a-v)O_2;$$

$$VO_2/HR = [SV \times HR \times (a-v)O_2]/HR = SV \times (a-v)O_2.$$

In a recent study it was shown that in children with asymptomatic preexcitation, major physical performance parameters measured by the CPET (VO_2 max, O_2 -pulse) are diminished when compared to the healthy controls, and that effect was stronger in patients with persistent delta-wave throughout the exercise [10].

Multiple studies proved that mechanical dyssynchrony is present in patients with preexcitation and could even lead to dilated cardiomyopathy which resolves following successful ablation [1–9]. Therefore, a hypothesis postulated herein is that in the state of the physical activity the dyssynchronous activation of the cardiac muscle could be affecting the stroke volume and CO and contributing to the diminution of VO_2 max and O_2 -pulse. Successful removal of the AP should then restore cardiac synchrony and improve oxygen consumption during exercise. The current results seem to confirm this hypothesis.

Results of the study show that in children with preexcitation the key parameters improve after the successful ablation of the accessory pathway. Results are encouraging and further investigations are needed to fully explain the present findings.

Interpretation of the results must be careful as the study group is small and does not allow for more detailed analysis of the subgroups

Conflict of interest: None declared

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