Evaluation of cardiac involvement in patients with clinical post-COVID-19 syndrome

M. Gorecka[1], N. Jex[1], S. Thirunavukarasu[1], A. Chowdhary[1], A.M. Poenar[1], N. Sharrack[1], P.P. Swoboda[1], H. Xue[2], V. Vassiliou[3], P. Kellman[2], S. Plein[1], A. Simms[4], J.P. Greenwood[1], E. Levelt[1]

[1]University of Leeds, Multidisciplinary Cardiovascular Research Centre and Biomedical Imaging Science Department, Leeds, United Kingdom; [2]National Heart Lung and Blood Institute, Bethesda, United States of America; [3]University of East Anglia, Norwich, United Kingdom; [4]Leeds Teaching Hospitals NHS Trust, Leeds, United Kingdom

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Introduction: The underlying pathophysiology of Post-COVID-19 syndrome remains unknown, but increased cardiometabolic demand and state of mitochondrial dysfunction have emerged as candidate mechanisms. Cardiovascular magnetic resonance (CMR) provides insight into pathophysiological mechanisms underlying cardiovascular disease and 31-phosphorus magnetic resonance spectroscopy (31P-MRS) allows non-invasive assessment of the myocardial energetic state.

Purpose: We sought to assess whether Post-COVID-19 syndrome is associated with abnormalities of myocardial structure, function, perfusion and tissue characteristics or energetic derangement.

Methods: Prospective case-control study. A total of 20 patients with a clinical diagnosis of Post-COVID-19 syndrome (seropositive) and no prior underlying cardiovascular disease (CVD) and ten matching controls underwent 31P-MRS and CMR at 3T at a single time point. (Figure 1) All patients had been symptomatic with acute COVID-19, but none required hospital admission.

Results: Between the Post-COVID-19 syndrome patients and matched contemporary controls there were no differences in myocardial energetics (phosphocreatine to ATP ratio), in cardiac structure (biventricular volumes, left ventricular mass), function (biventricular ejection fractions, global longitudinal strain), tissue characterization (T1 and extracellular volume [ECV] fraction mapping, late gadolinium enhancement) or perfusion (myocardial rest and stress blood flow, myocardial perfusion reserve). One patient with Post-COVID-19 syndrome showed subepicardial hyperenhancement on the late gadolinium enhancement imaging compatible with prior myocarditis, but no accompanying abnormality in cardiac size, function, perfusion, ECV, T1, T2 mapping or energetics. This patient was excluded from statistical analyses. (Table 1)

Conclusion: In this study, the overwhelming majority of patients with a clinical Post-COVID-19 syndrome with no prior CVD did not exhibit any abnormalities in myocardial energetics, structure, function, blood flow or tissue characteristics.

Table 1. Comparison of ^{31}P-MRS and CMR findings between patients with Post-COVID-19 syndrome and healthy volunteers

Variable	Healthy volunteers (n=10)	Post-COVID-19 Syndrome (n=19)	p-value
PCr/ATP ratio	2.11±0.5	2.24±0.4	0.49
LV end diastolic volume (ml)	158±39	152±22	0.68
LV end diastolic volume index (ml/m^2)	87±20	81±10	0.43
LV end systolic volume (ml)	57±12	60±12	0.50
LV end systolic volume index (ml/m^2)	31±7	32±6	0.83
LV stroke volume (ml)	101±28	87 [81-110]	0.26
LV ejection fraction (%)	64±4	61±4	0.07
RV end diastolic volume (ml)	170±46	156±29	0.41
RV end diastolic volume index (ml/m^2)	93±23	83±13	0.24
RV end systolic volume (ml)	76±25	67±18	0.34
RV end systolic volume index (ml/m^2)	42±12	36±9	0.20
RV stroke volume (ml)	93±29	89±17	0.64
RV ejection fraction (%)	55±8	57±6	0.49
Peak circumferential strain (%)	-21.0±2.1	-20.7±3.3	0.77
Global longitudinal strain (%)	-13.3±2.3	-11.9±3.7	0.21
Peak diastolic circumferential strain rate (1/s)	1.3±0.2	1.3±0.3	0.80
Peak diastolic longitudinal strain rate (1/s)	1.0±0.2	1.0±0.4	0.98
Mean T1 (ms)	1206±64	1158±114	0.15
Extra-cellular volume (%)	25±2.3	22±4.5	0.03
T2 (ms)	39±2.4	40±2.9	0.46
MBF rest (ml/g/min)	0.7±0.1	0.8±0.3	0.20
MBF stress (ml/g/min)	2.0±0.5	2.1±0.5	0.74
MPR	3.1±0.9	3.0±0.8	0.89

Continuous variables are expressed as mean (SD) or median (IQR) and categorical variables as number (%). PCr/ATP=phosphocreatine and adenosine triphosphate ratio; LV=left ventricular; ml=milliliter; ml/m2=milliliters per square meter of body surface area; g=grams; RV=right ventricular; MBF=myocardial blood flow; ms=milliseconds; MPR=myocardial perfusion reserve.

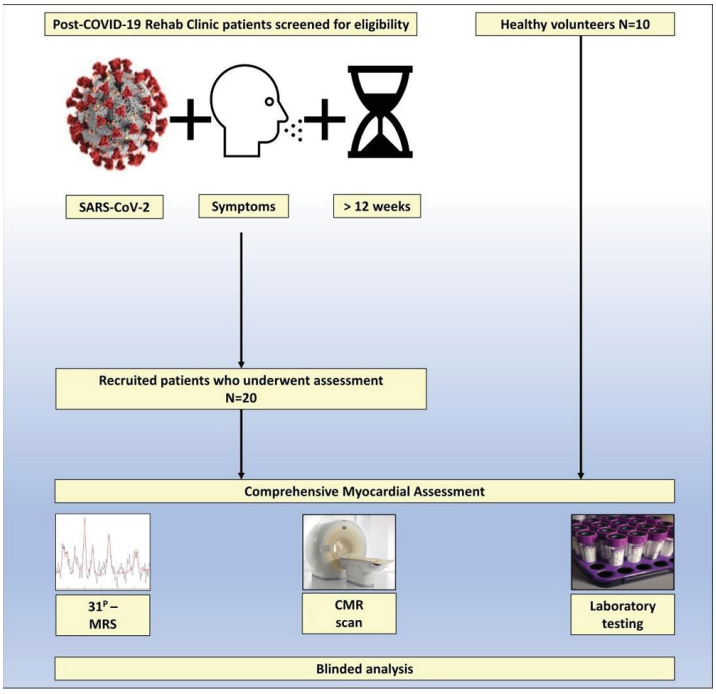

Figure 1. Study design.