Altered Ventilation efficiency at exercise after recovery from COVID-19 infection versus healthy controls

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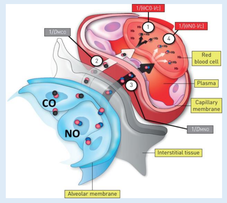
Background

- Long-term dyspnea and reduced exercise capacity are the most common symptoms reported by long covid patients and the cause is still unknow. [1,4]
- Double pulmonary diffusing capacity (DLNO/CO) is able to dissociate the membrane component (Dm) and the capillary volume (Vc) participating in gas exchange. [2]
- Roughton-Forster equation [3]

$$\frac{1}{DLCO} = \frac{1}{Dm_{CO}} + \frac{1}{(\Theta_{CO}.Vc)}$$

$$\frac{1}{DLNO} = \frac{1}{Dm_{NO}} + \frac{1}{(\Theta_{NO}.Vc)}$$



- Cardiopulmonary exercise testing (CPET) is the gold standard for measuring aerobic capacity and diagnosing exercise-induced dyspnea. [4]

Aims of the study

- Investigate DLNO/CO at rest and submaximal exercise in post-COVID-19.
- Investigate cardiopulmonary response and aerobic capacity in long COVID-19 patients.

Methods

Population (N=40)

- 20 non hospitalized COVID-19 patients (COVID) were tested at 4 ± 2 months post infection, along with 20 healthy subjects (CTL) matched by sex/age/BMI.
- Inside the COVID-19 patients, 10 patients met the definition of long-COVID (Long COVID). [5]

Protocol

- Single visit including measurement at baseline and after exercise.

Baseline : quality of life (SF-36), 6 minute walk test (6MWT), lung function (FEV_1), double pulmonary diffusion (DLNO/CO).

At exercise: DLNO/CO after 10 minutes of cycling at 85% of the maximal heart rate measured during the 6MWT (85% HR_{6MWT}).

Measurements (N=40)

SF-36 → 6MWT → FEV_1 → DLNO/CO → Cycling at 85% HR_{6MWT} → DLNO/CO

*CPET (N=10)

* Only the 10 long COVID performed a CPET

Results

COVID versus CTL (N=40)

No differences were observed between the groups regarding the measurements of SF-36, 6MWT, FEV_1, DLNO/CO.

Long COVID versus CTL

Population characteristics

	Long COVID (N =10)	CTL (N=10)
Sex (F) %	90	90
Age (year)	28 ± 14	31 ± 15
BMI (kg/m2)	22,6 ± 3,4	21,8 ± 2,1
SF-36	69 ± 21	83 ± 11
Distance (m)	669 ± 83	648 ± 74
FEV_1 (% pred)	101 ± 17	103 ± 11

CPET in long covid and healthy subjects (CTL database)

	Long COVID (N=10)	CTL database (N=10)
VE/VCO_2 slope	**31,9 ± 5,2#**	26,1 ± 2,2
VO_{2max} (%pred)	85 ± 20	97 ± 16

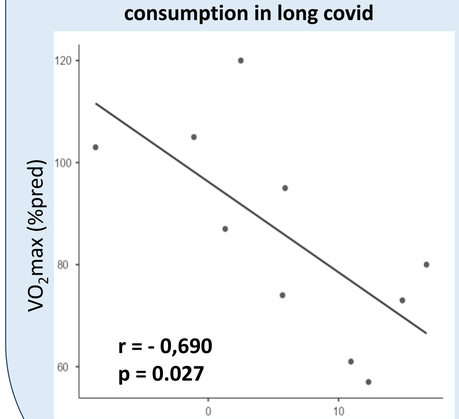
# p<0.05 : different from CTL
Database : CPET data from healthy subject sourced from the laboratory's database (matched by sex/age/BMI)

DLNO/CO at rest and after submaximal exercise

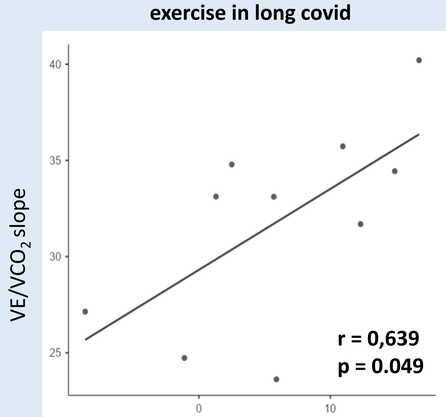
	Long COVID (N =10)		CTL (N=10)	
	Baseline	Exercise	Baseline	Exercise
DLNO (% pred)	87 ± 16	106 ± 16 ***ΔΔ	91 ± 11	100 ± 15***
DLCO (% pred)	79 ± 16	92 ± 16***	79 ± 10	90 ± 16***
Alveolar volume (%pred)	92 ± 12	97 ± 12**Δ	100 ± 1	101 ± 12
Dm (ml/min/mmHg)	65 ± 24	79 ± 25***ΔΔ	67 ± 18	75 ± 21***
Vc (ml)	66 ± 26	72 ± 24	65 ± 18	71 ± 26

*p<0.05,**p<0.01,***p<0.001 : difference between rest and exercise
Δ p<0.05, ΔΔ p<0.01, ΔΔΔp<0.001 : exercise-induced greater evolution in long COVID compared to CTL.

Correlation between the delta of capillary volume (ΔVc) evolution and predicted oxygen consumption in long covid



Correlation between the delta of capillary volume (ΔVc) evolution and the ventilatory response to exercise in long covid



Conclusion

- The **greater increase** in the membrane diffusion (**Dm**) in **long COVID**, compared to their control for the **same level of submaximal exercise**, suggests an **altered diffusing capacity**.
- A **ventilatory inefficiency** during exercise and a **reduced trend** in **maximal aerobic capacity appear** to **be correlated** with **greater** exercise-induced **changes in capillary volume in long COVID-19 patients**.

References

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Abbreviation: DLNO/DLCO : double pulmonary diffusing capacity; NO: nitric oxide; CO: carbon monoxide; Dm: membrane component; Vc: capillary volume; Θ : affinity of the gaz for haemoglobin; CPET: Cardiopulmonary exercise test; COVID: non-hospitalized post-COVID patients; CTL: healthy subjects; VE/VCO_2 slope: ventilatory response to exercise, VO_2max : oxygen consumption at maximal exercise; ΔVc: delta of capillary volume between baseline and exercise.