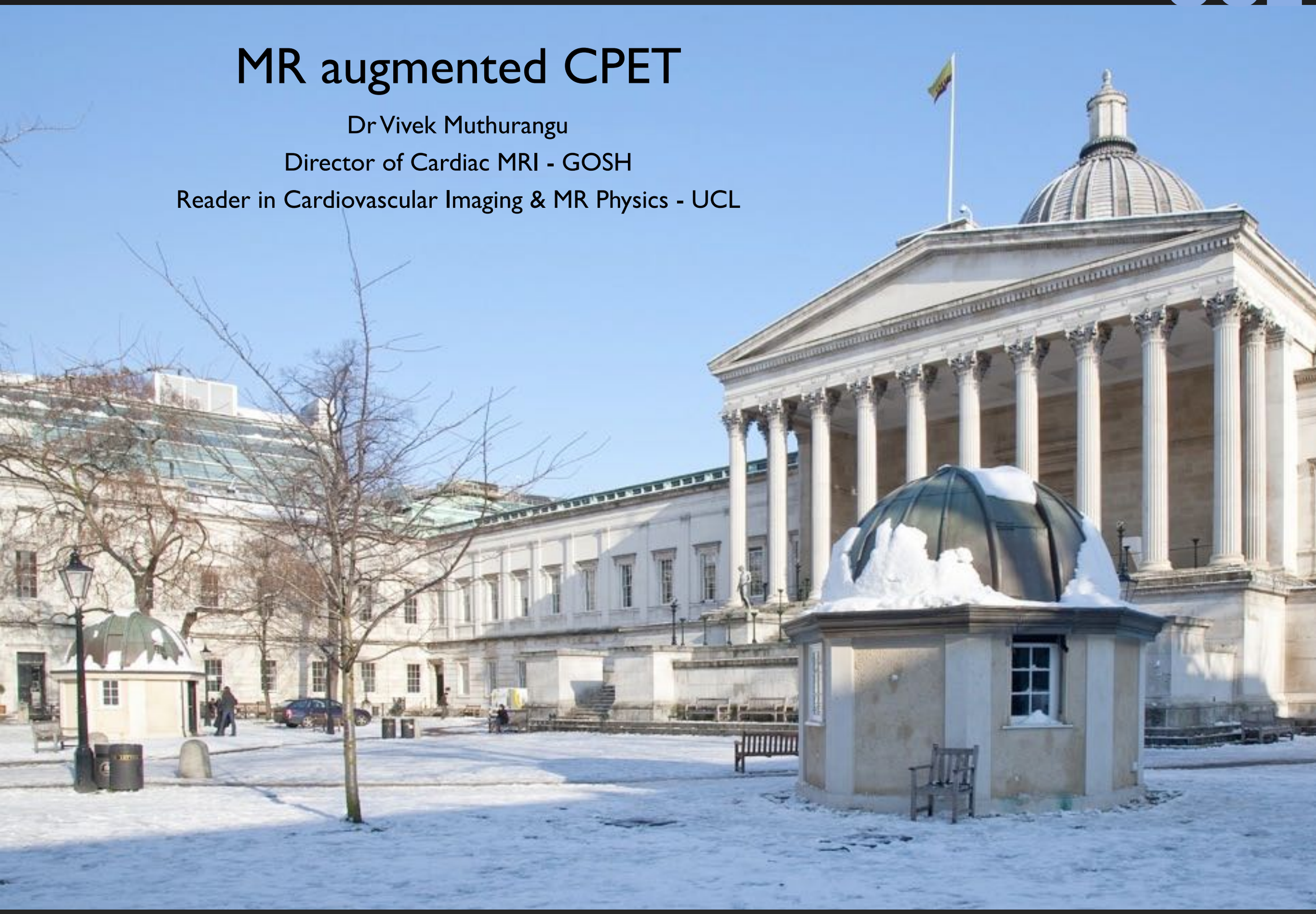
MR augmented CPET

Dr Vivek Muthurangu

Director of Cardiac MRI - GOSH

Reader in Cardiovascular Imaging & MR Physics - UCL

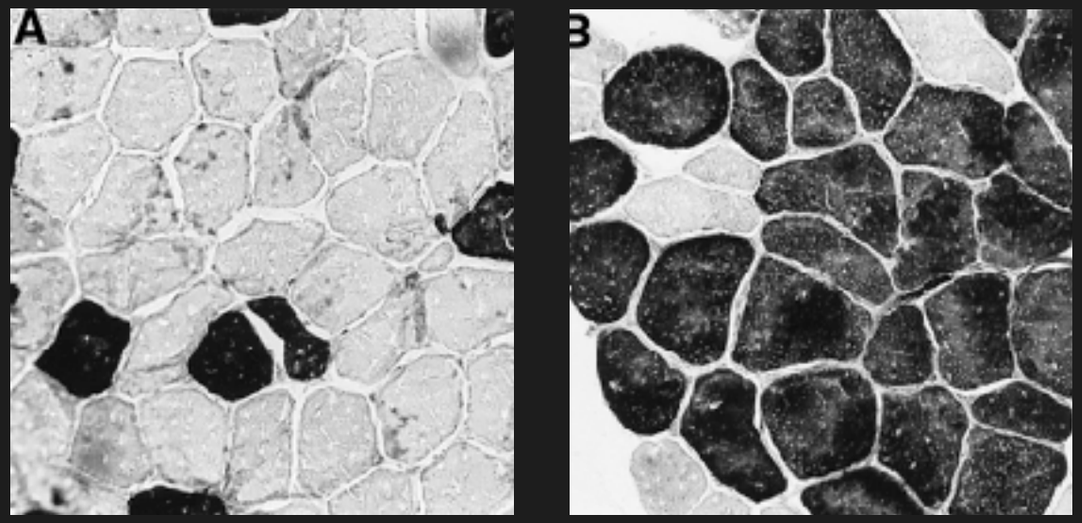


- No disclosures

Exercise intolerance

Exercise intolerance

Exercise intolerance



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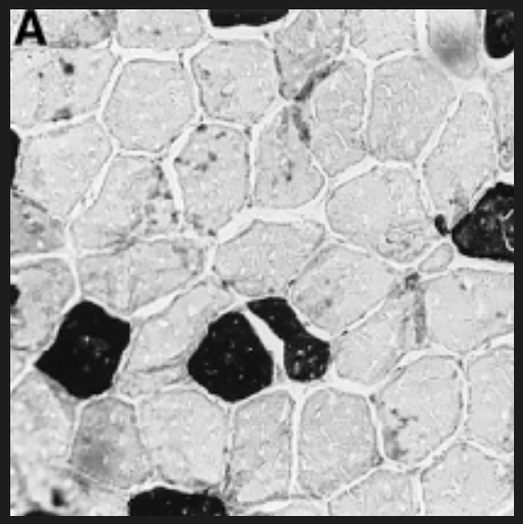

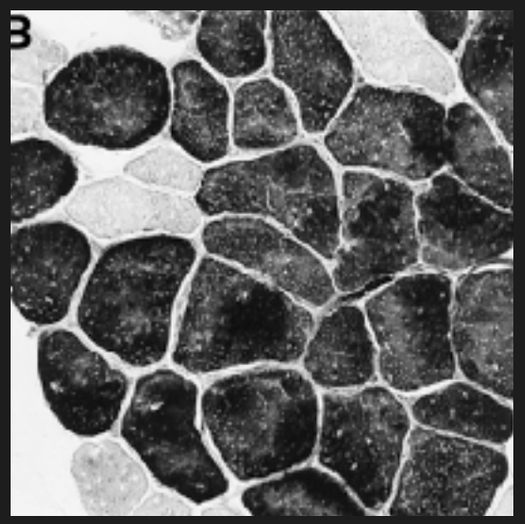

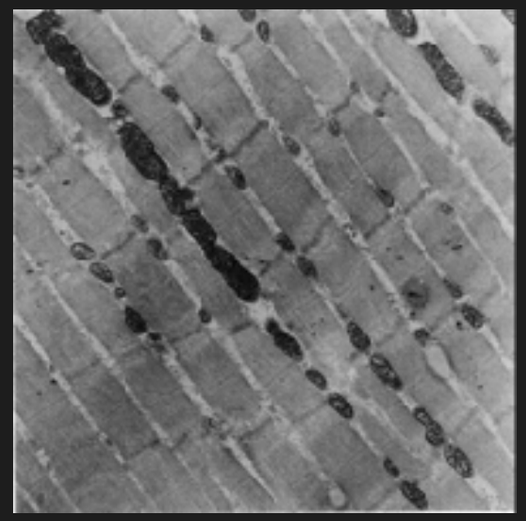

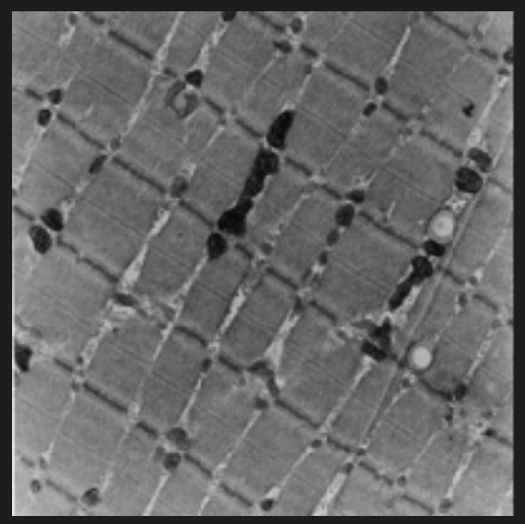

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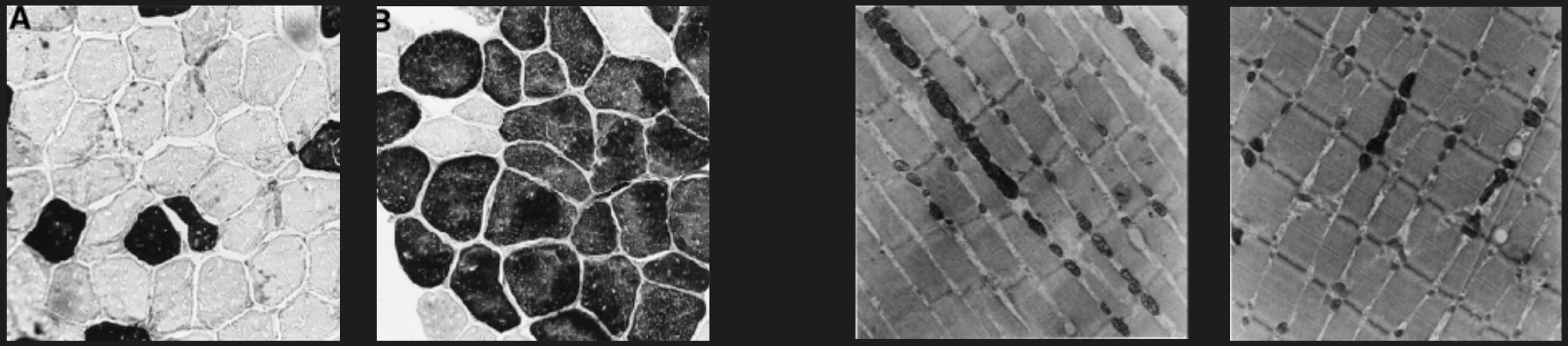
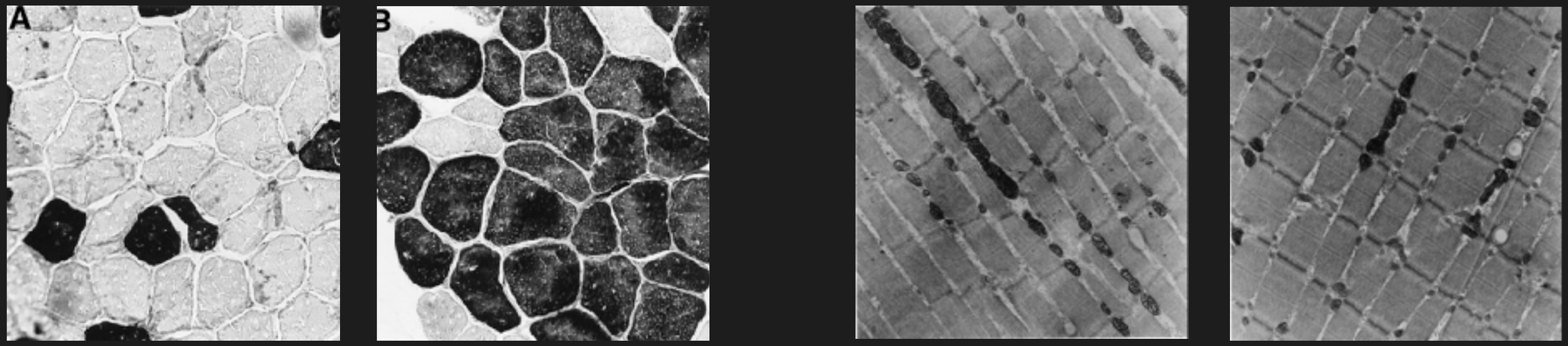


Tissue O_2 extraction

Exercise intolerance



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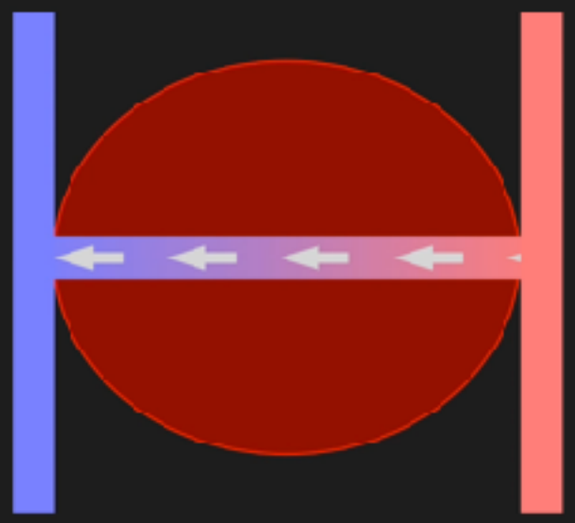

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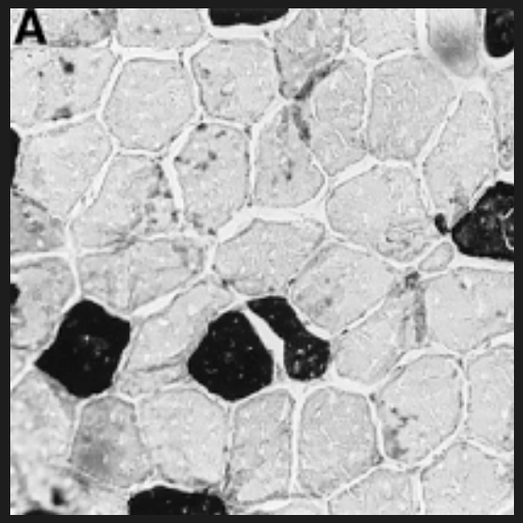
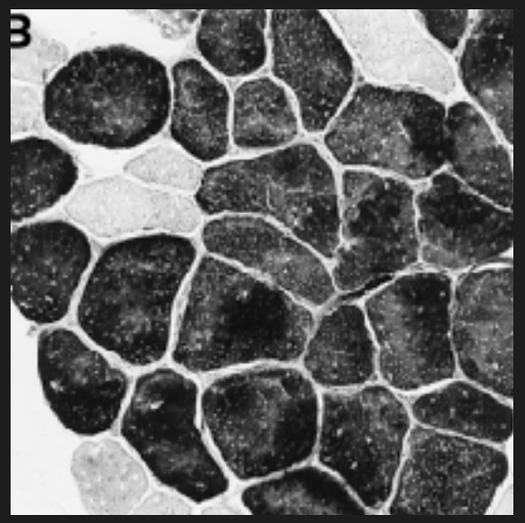
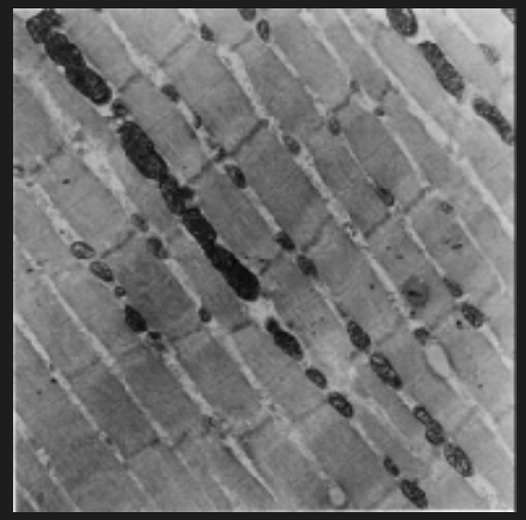
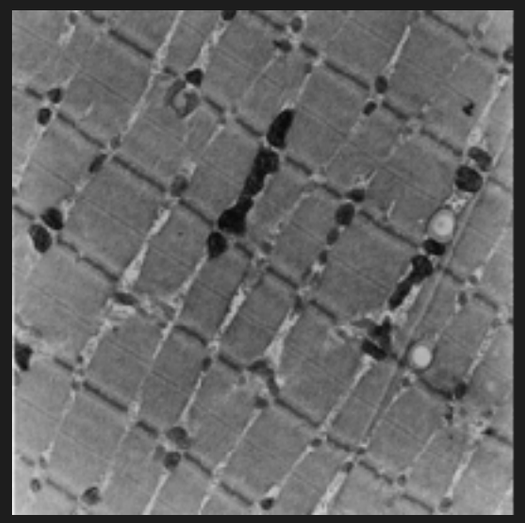


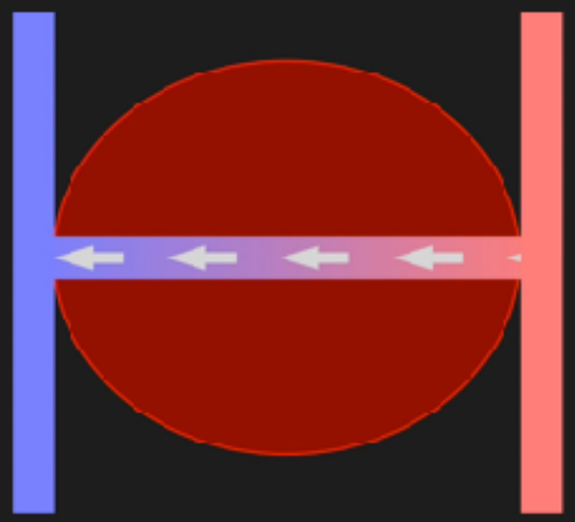






Tissue O_2 extraction

40%



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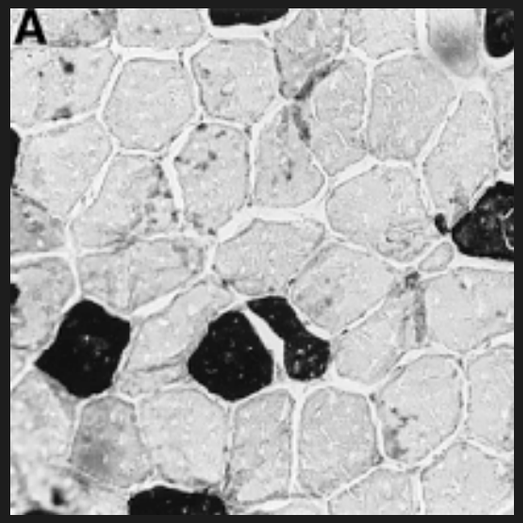

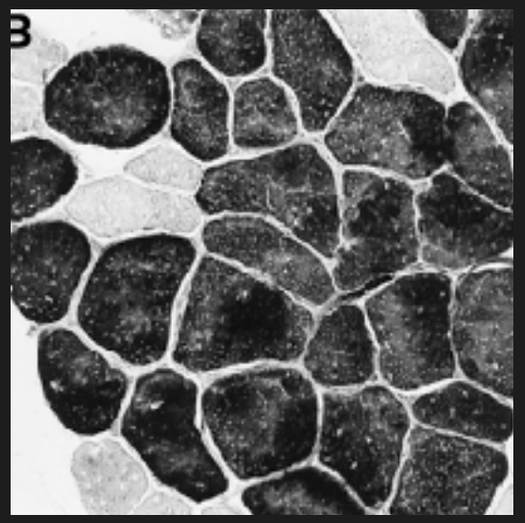

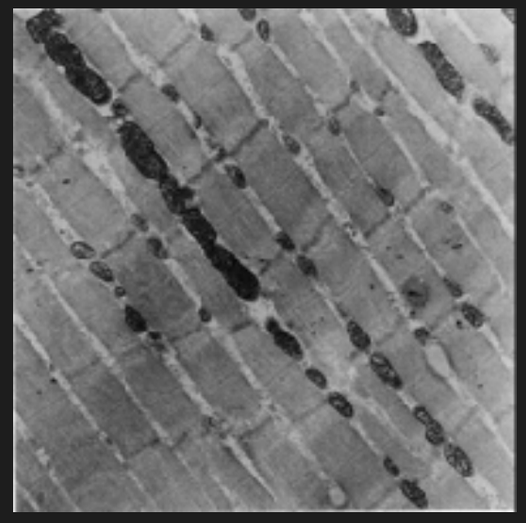

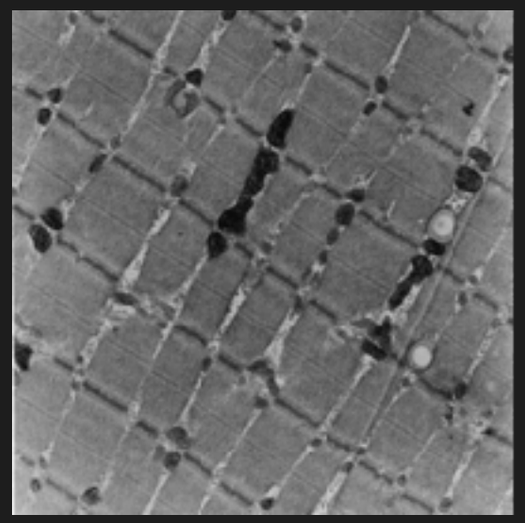

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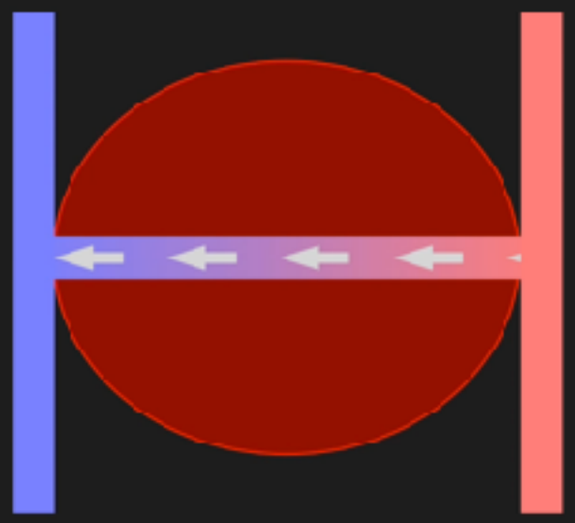

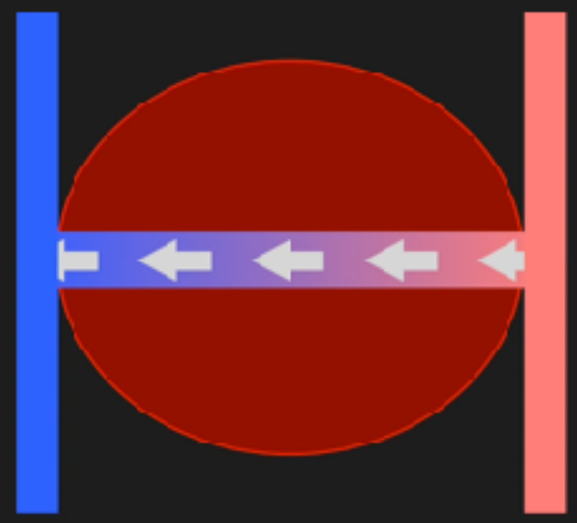

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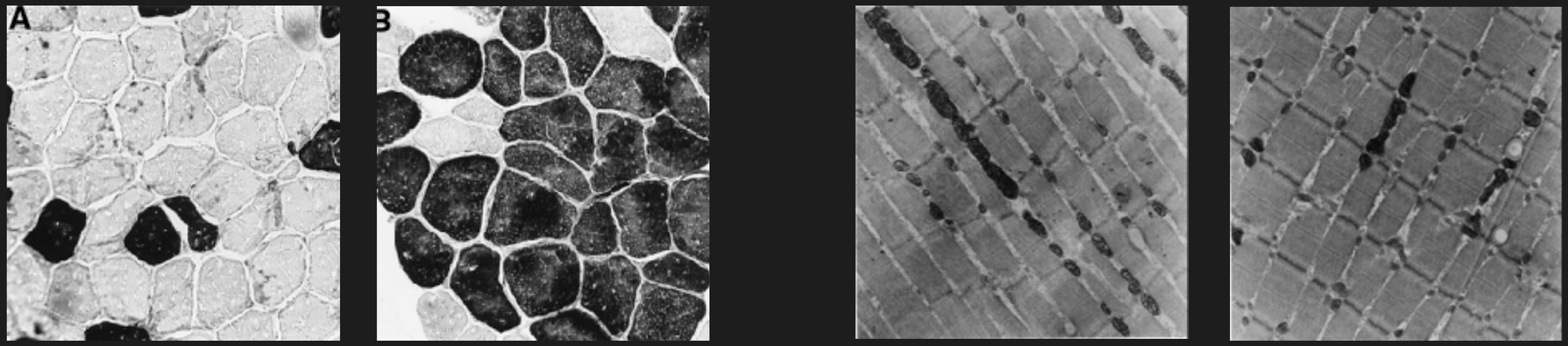

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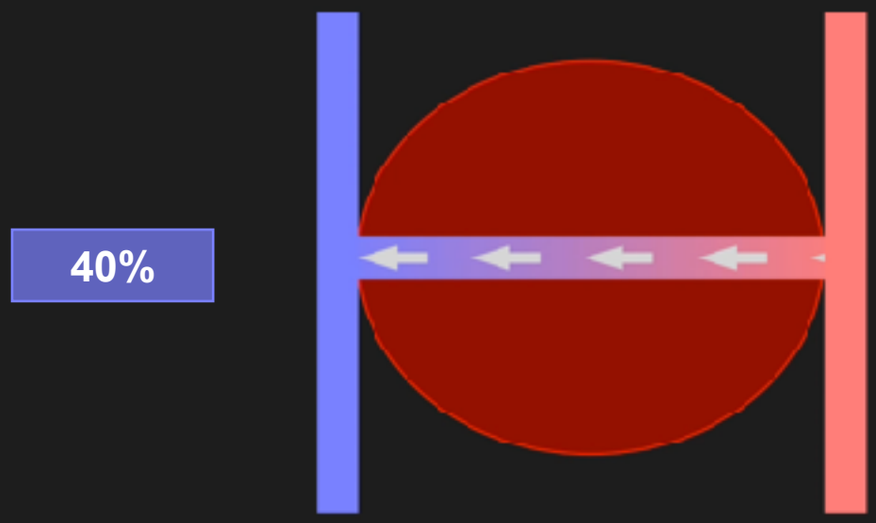

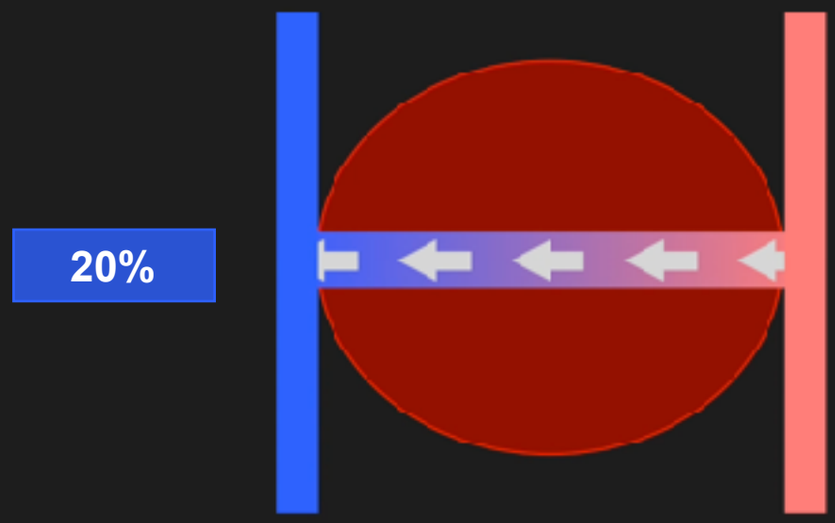

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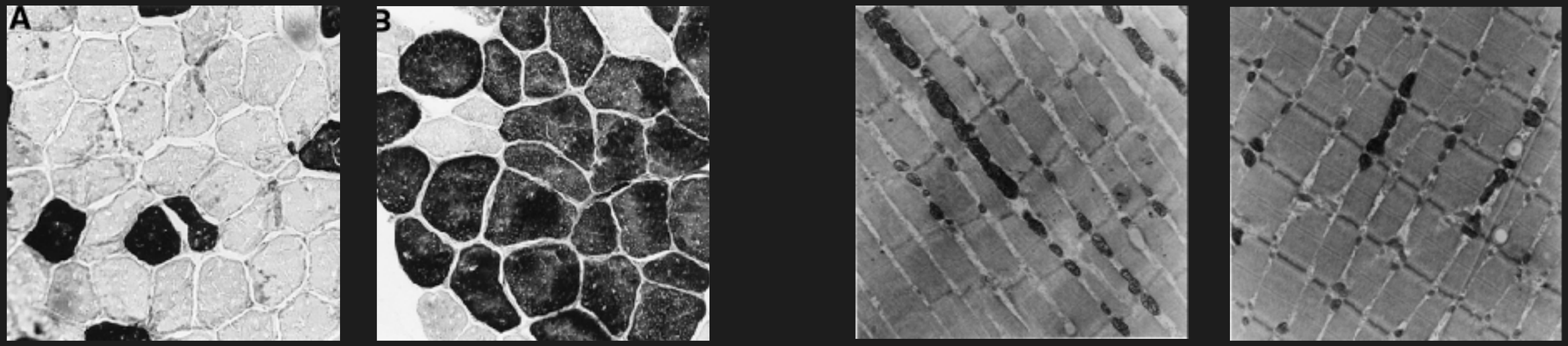

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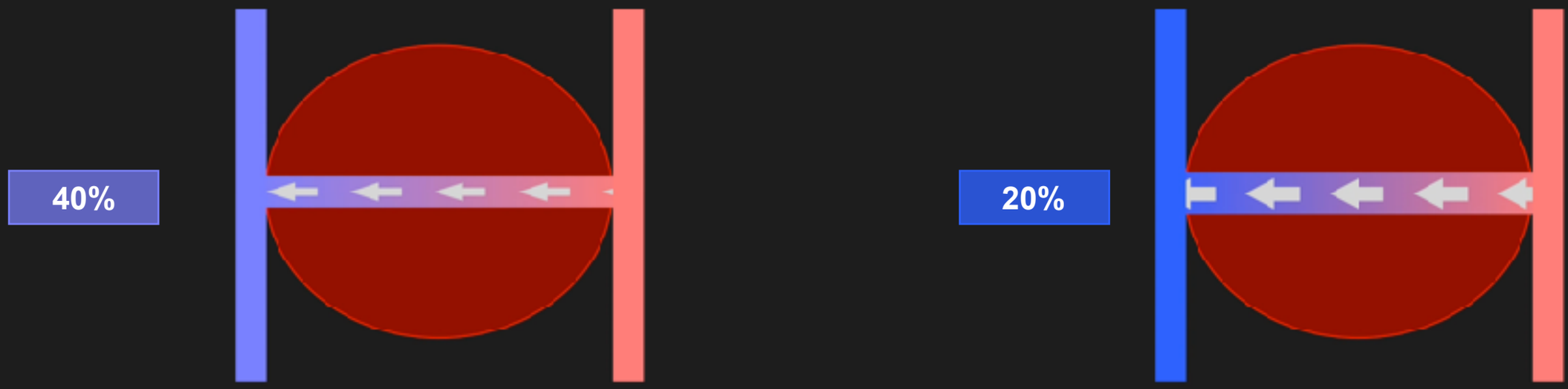

Aterio-venous O_2 content difference

Fick principle

Fick principle

Fick principle

$$CO = \frac{VO_2}{\Delta a\text{-}vO2}$$

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Measure CO + VO_2

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Measure CO + VO_2

MR compatible exercise

In scanner - bore size

Different vendors

Fick principle

$$CO = \frac{VO_2}{\Delta a\text{-}vO2} \qquad \Delta a\text{-}vO2 = \frac{VO_2}{CO}$$

Measure CO + VO_2

MR compatible exercise
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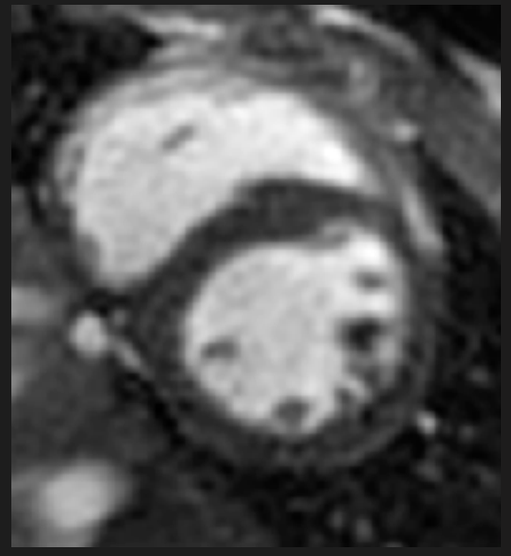

Volumetric
Real-time (temp res)
Radial SSFP

Fick principle

$$CO = \frac{VO_2}{\Delta a\text{-}vO2} \qquad \Delta a\text{-}vO2 = \frac{VO_2}{CO}$$

Measure CO + VO_2

MR compatible exercise
In scanner - bore size
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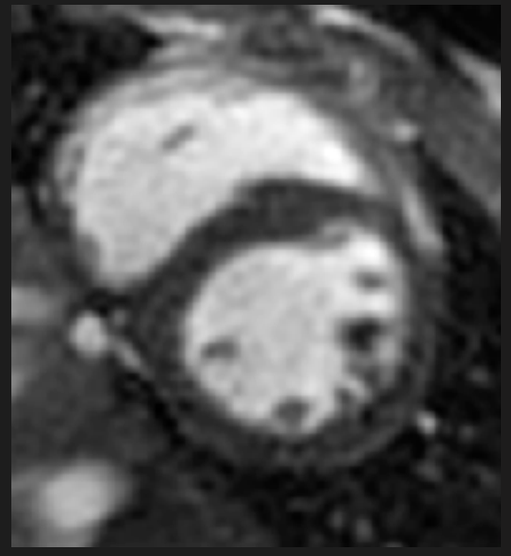

Volumetric
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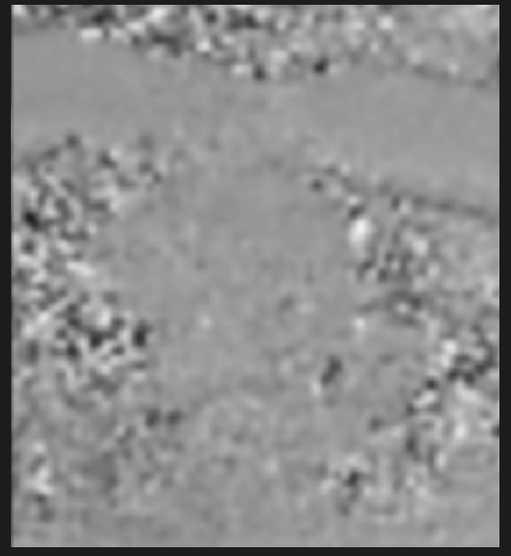


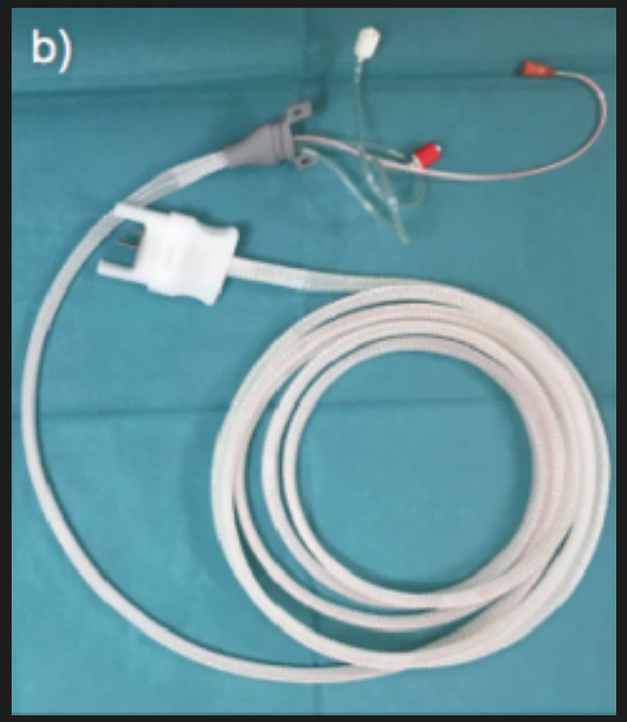
Flow
Real-time (temp res)
Spiral PCMR

UCL

Measuring VO2 in scanner

Measuring VO2 in scanner

Measuring VO2 in scanner



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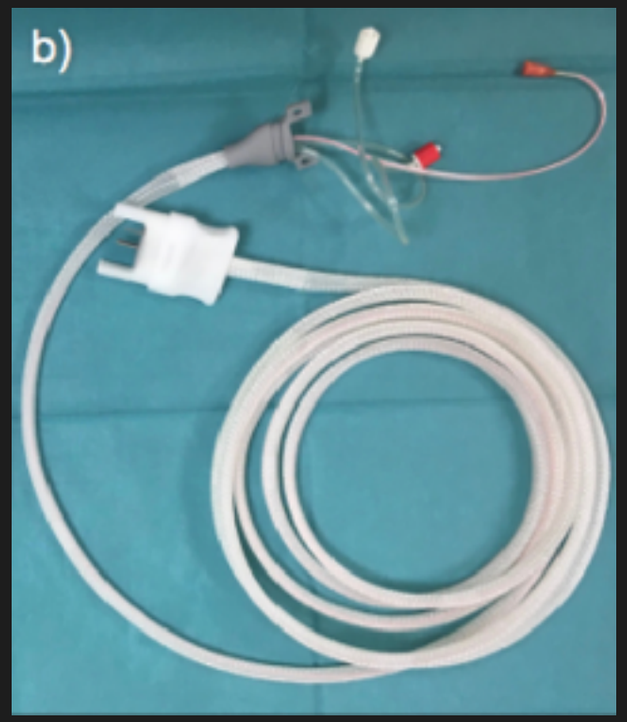
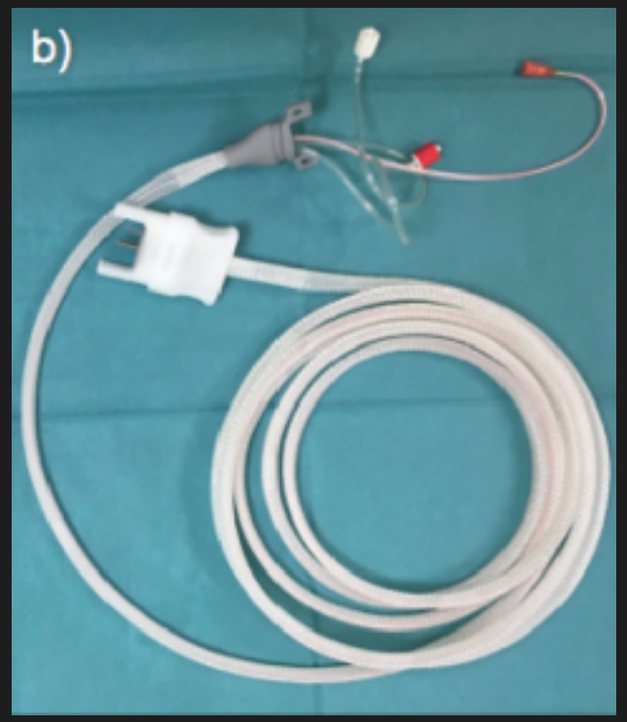
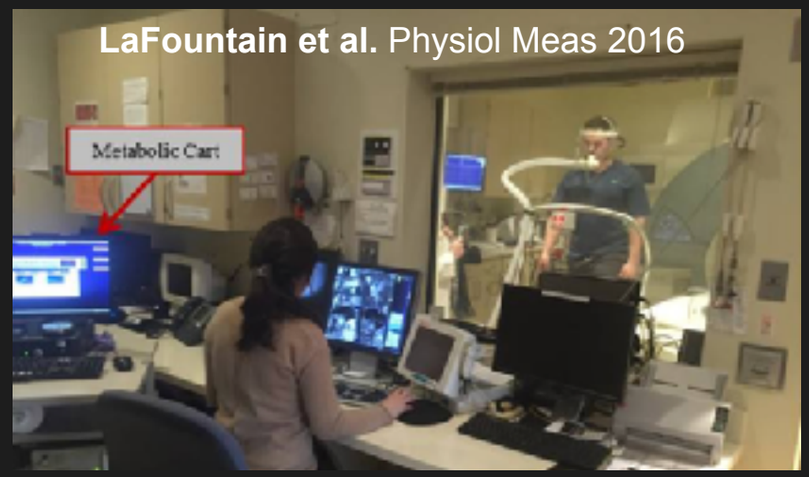


8m tube

Measuring VO2 in scanner

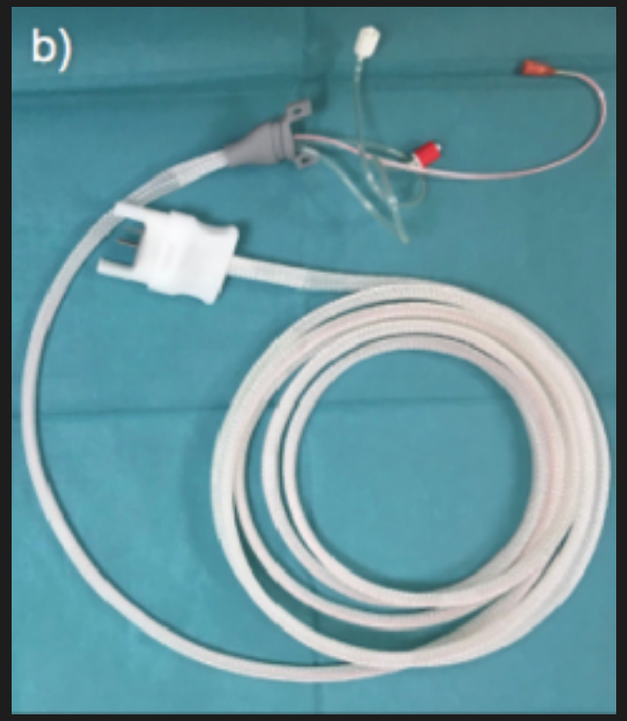


8m tube

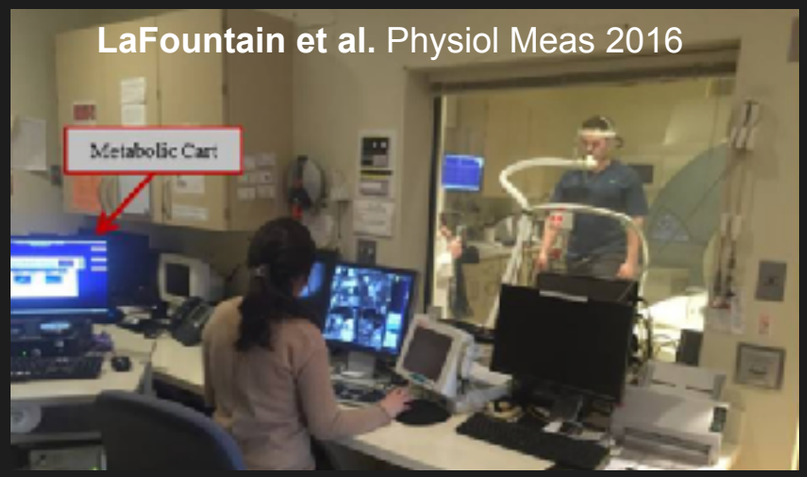


15m tube

Measuring VO2 in scanner



8m tube



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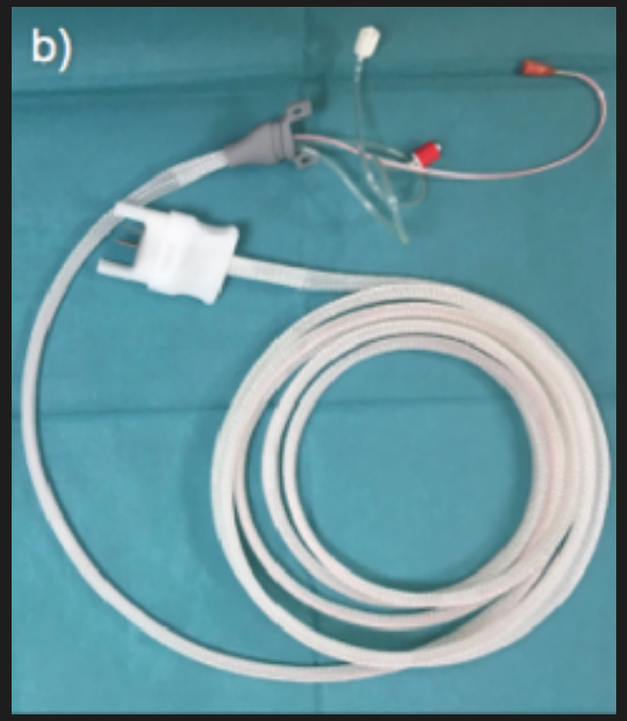

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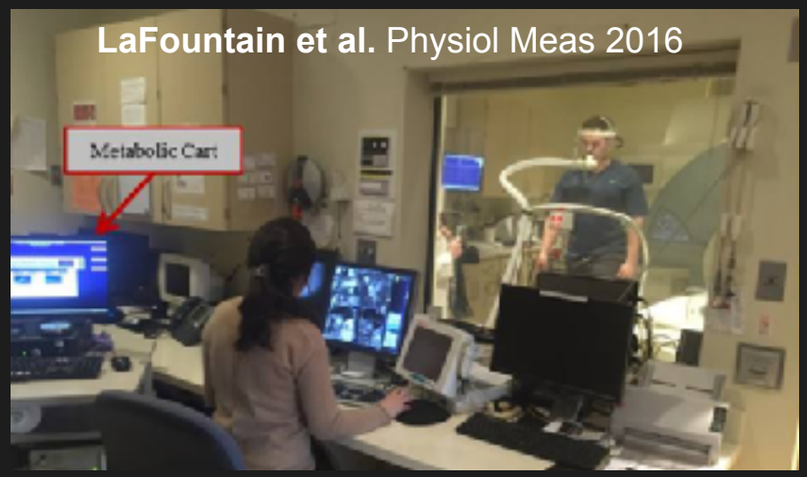

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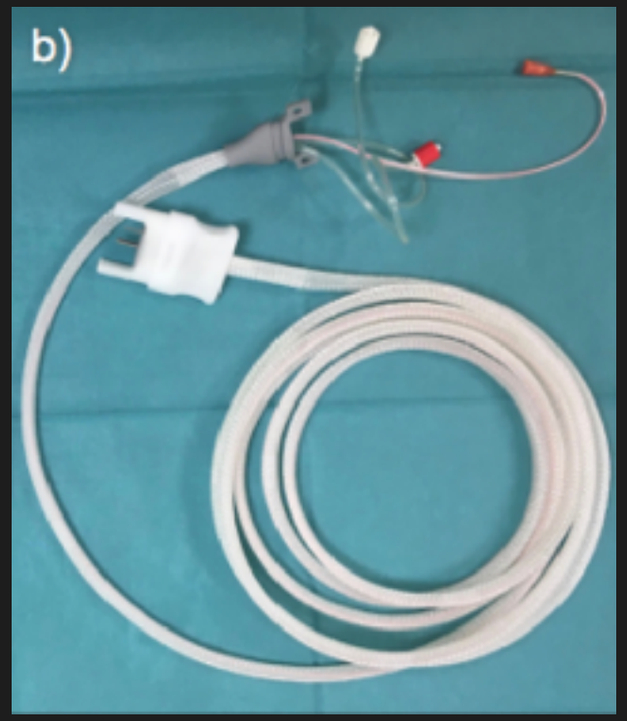

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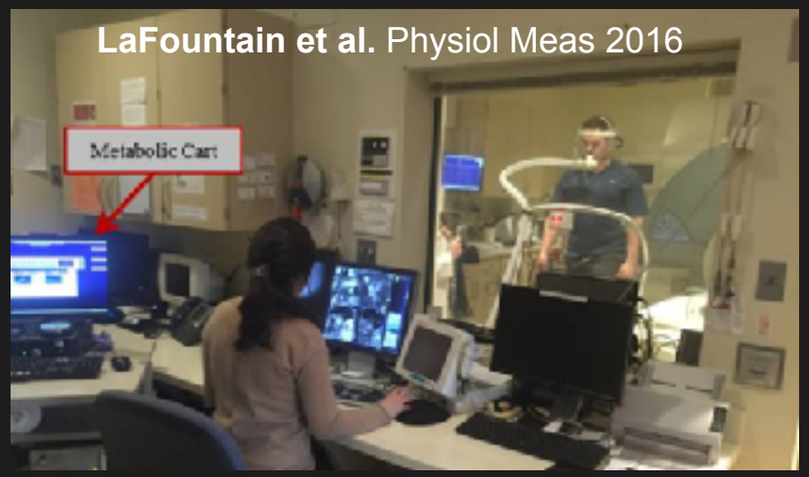

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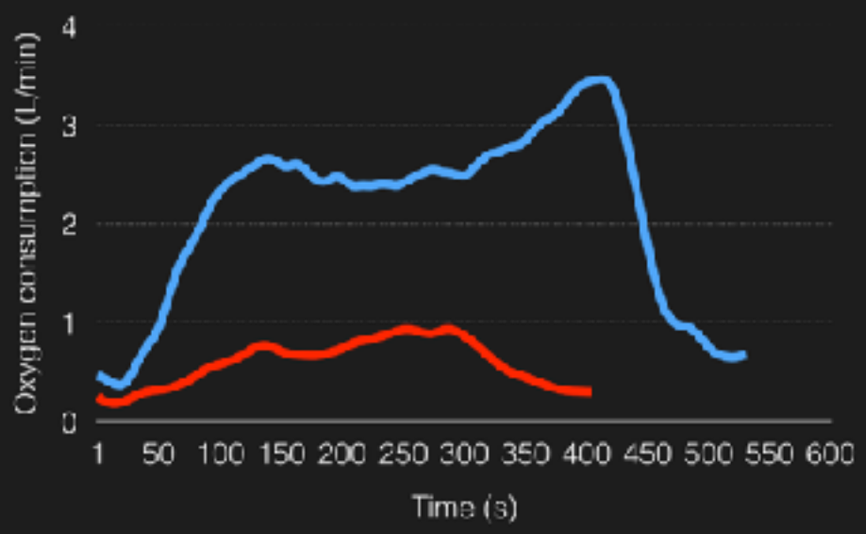
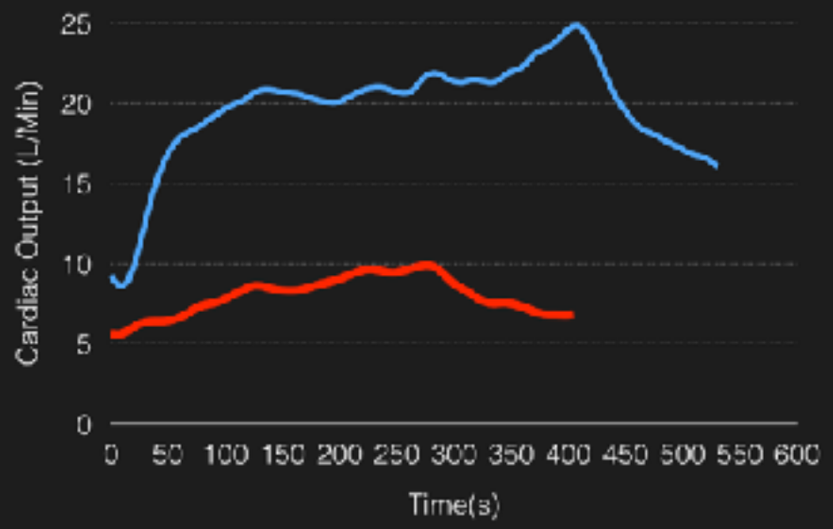




Continuous CO and VO_2

Barber et al. Physiol Meas 2015

Validation and feasibility

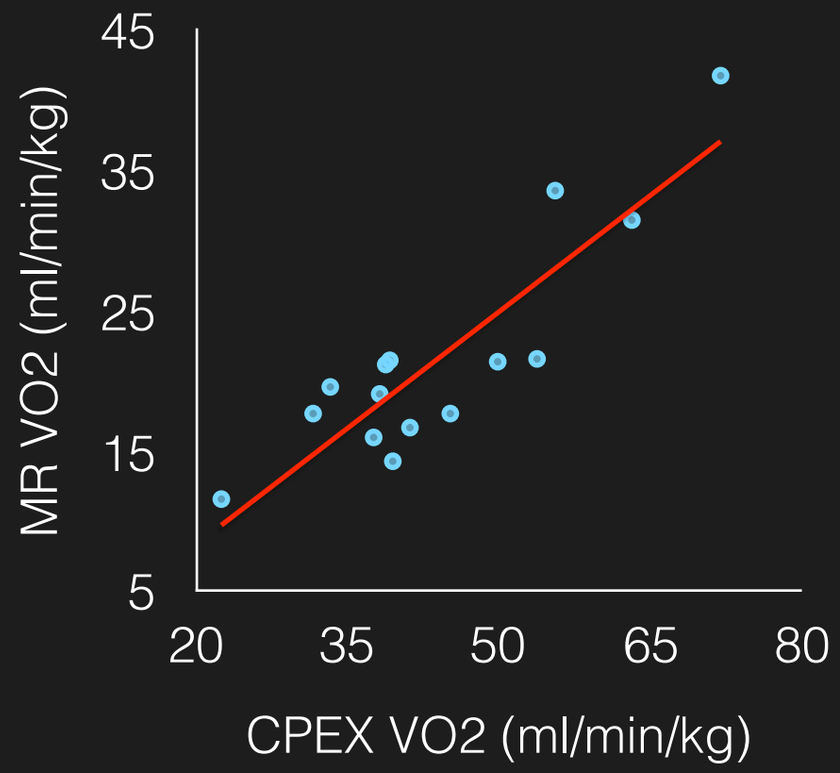
Validation and feasibility

15 volunteers

Validation and feasibility

15 volunteers

R = 0.94



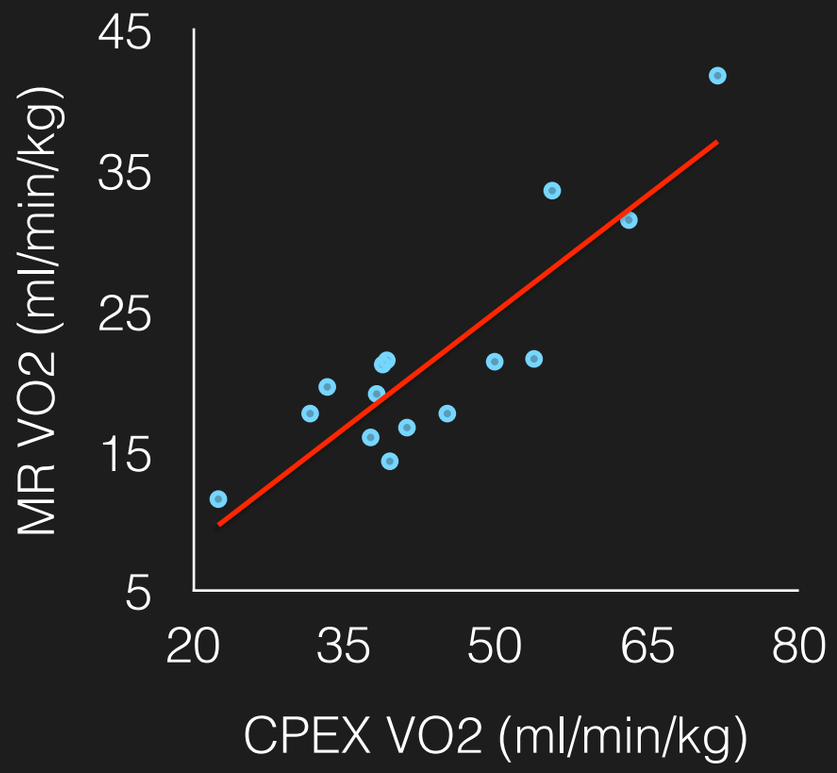
Validation and feasibility

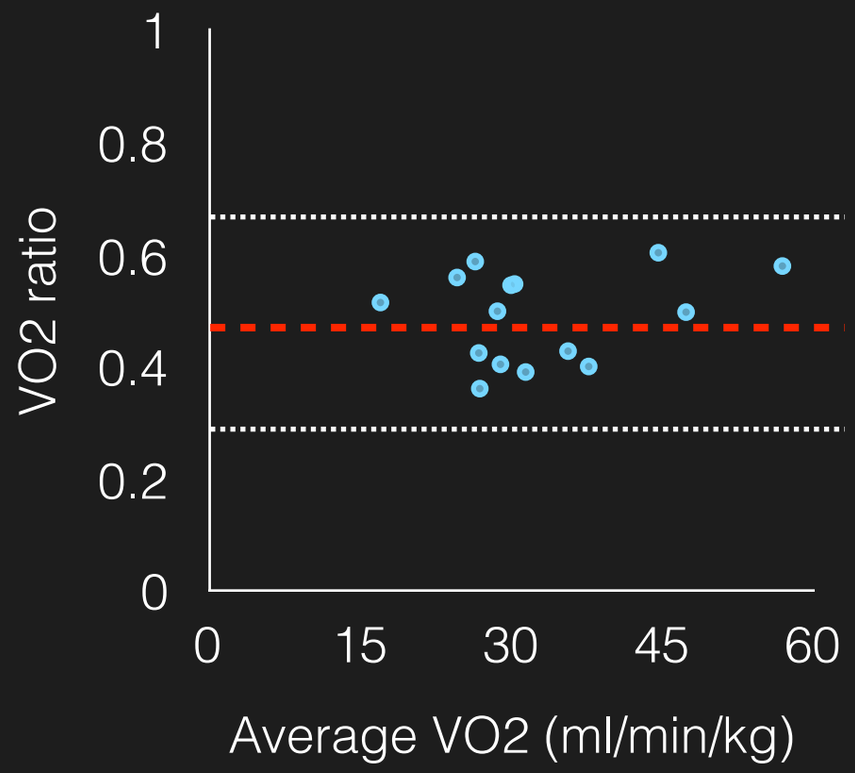
15 volunteers

R = 0.94

Bias (ratio = 0.48)

Barber et al. *Physiol Meas 2015*





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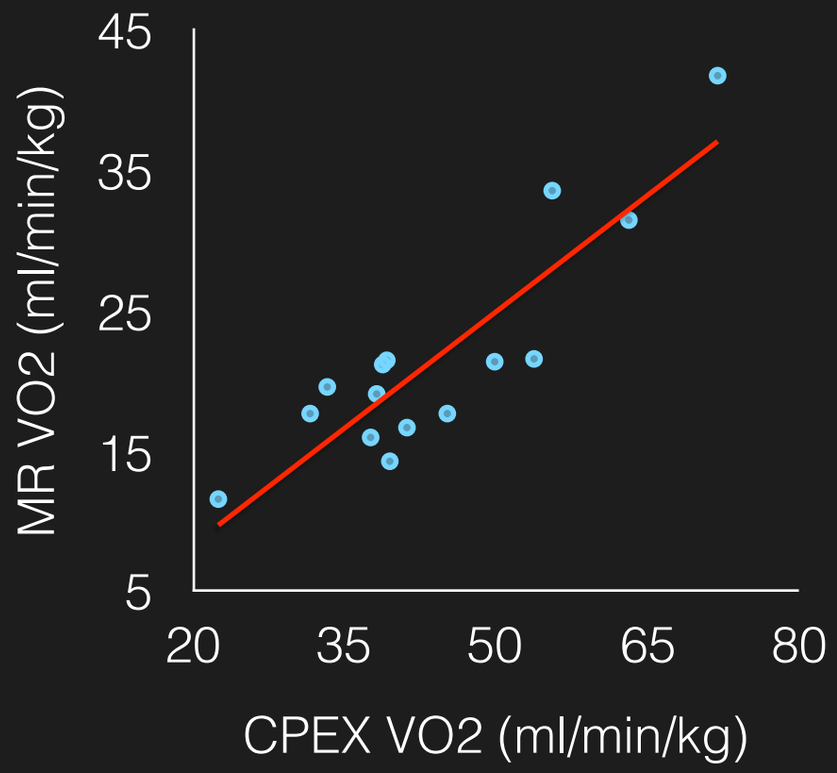
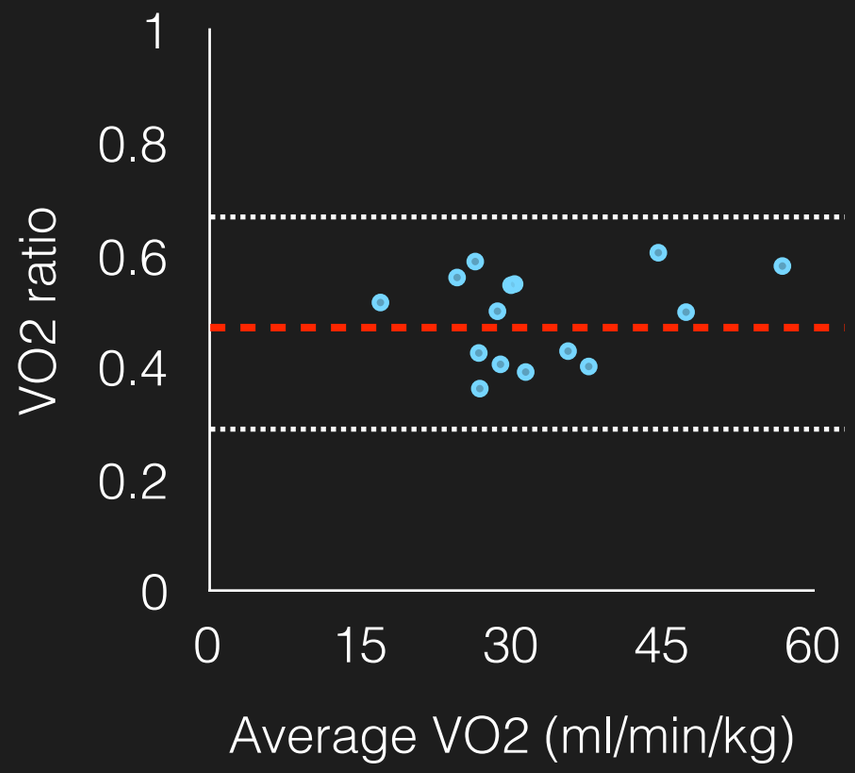




1 min rest | **Start. 2 min unloaded. 2Watts/min 5 min 3Watts min to peak** | **Unload. Recovery**

Resting RT-SSFP Short Axis Stack

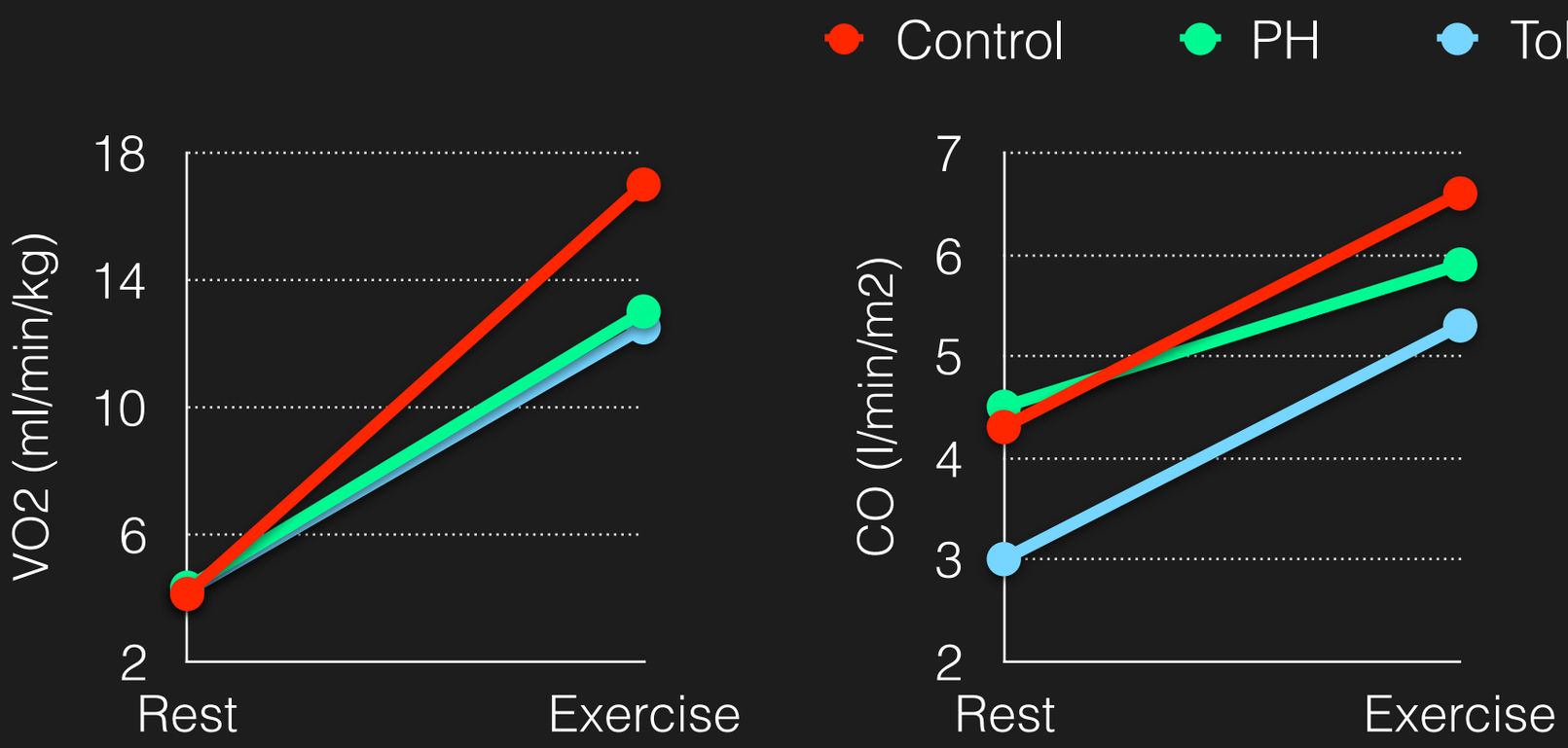
Peak RT-SSFP Short Axis Stack

Continuous Real Time CO measurement | **Real Time CO**

Continuous breath by breath CPET

Patient study

Patient study



Barber et al. Circ CV Imag *2016*

Patient study

Barber et al. Circ CV Imag *2016*

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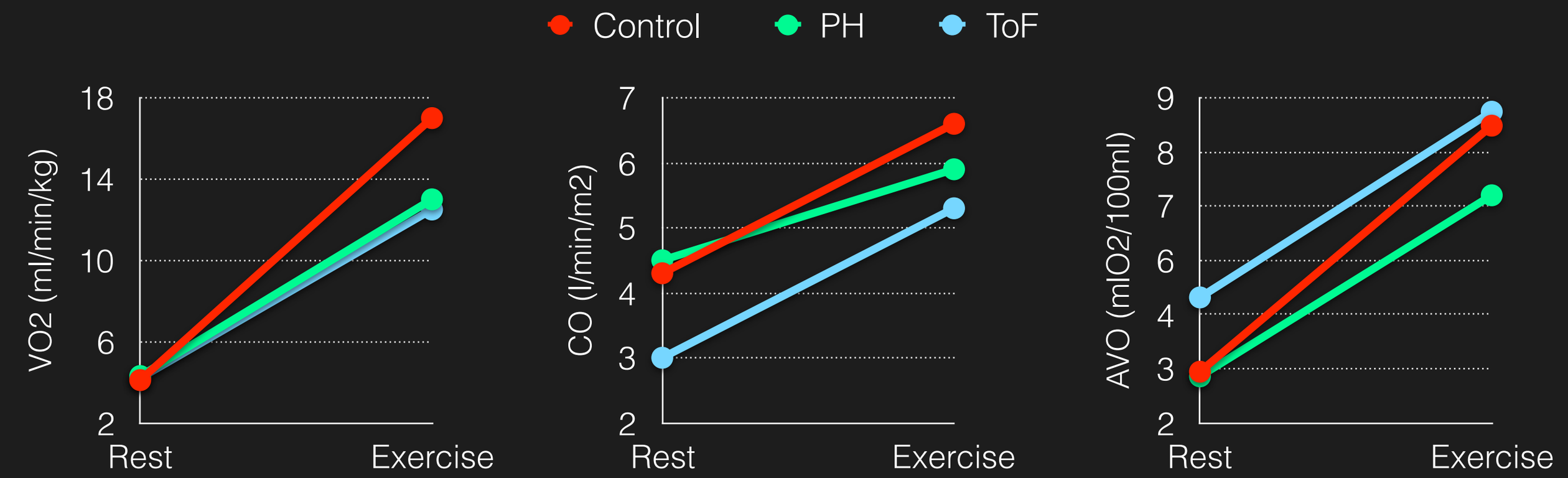

Barber et al. Circ CV Imag *2016*

Exercise CMR-CPEX - Fontan

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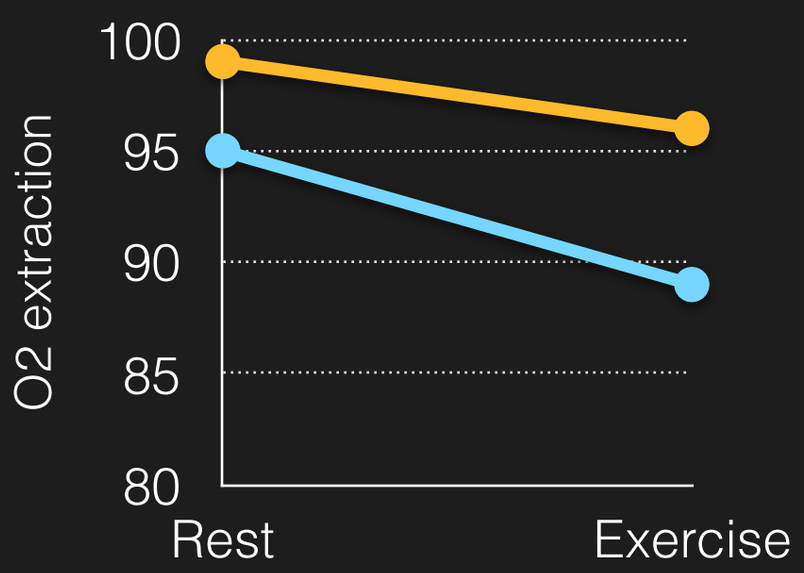
T2* IDEAL

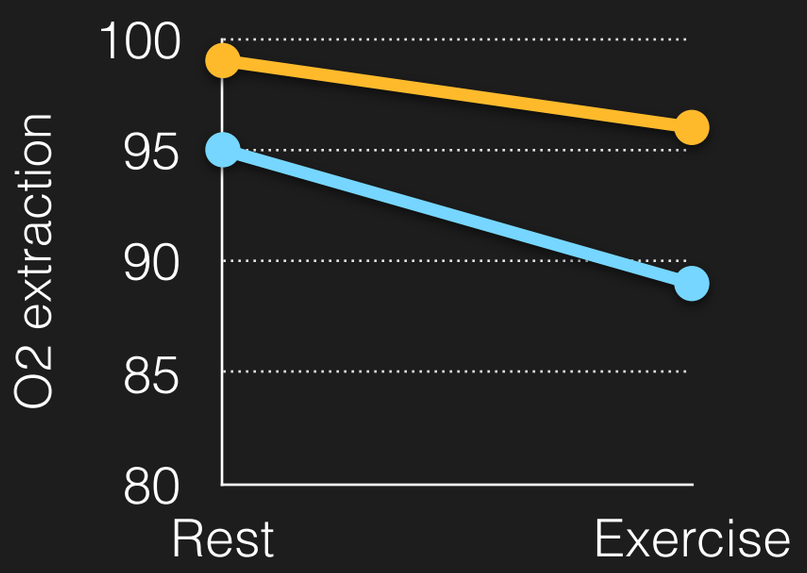
Exercise CMR-CPEX - Fontan

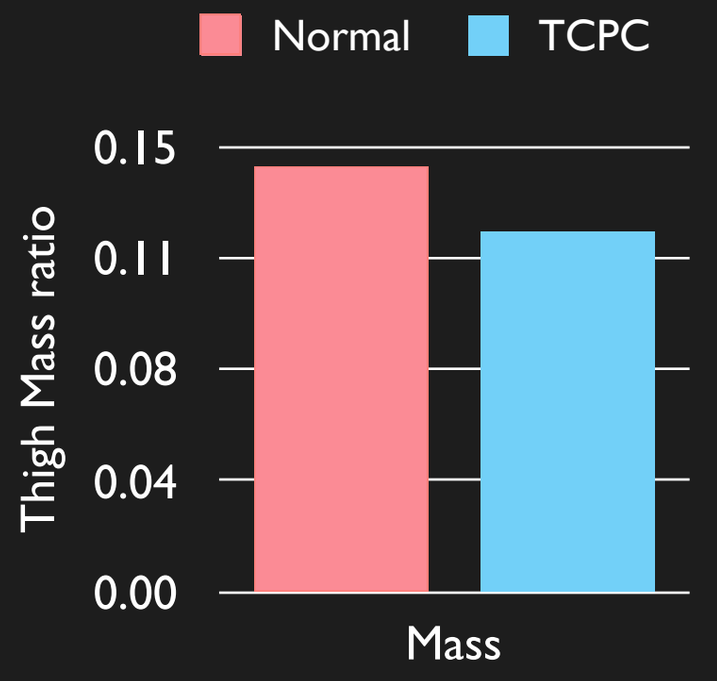


No association

T2* IDEAL

Exercise CMR-CPEX - Fontan





No association

T2* IDEAL

No association

Conclusion

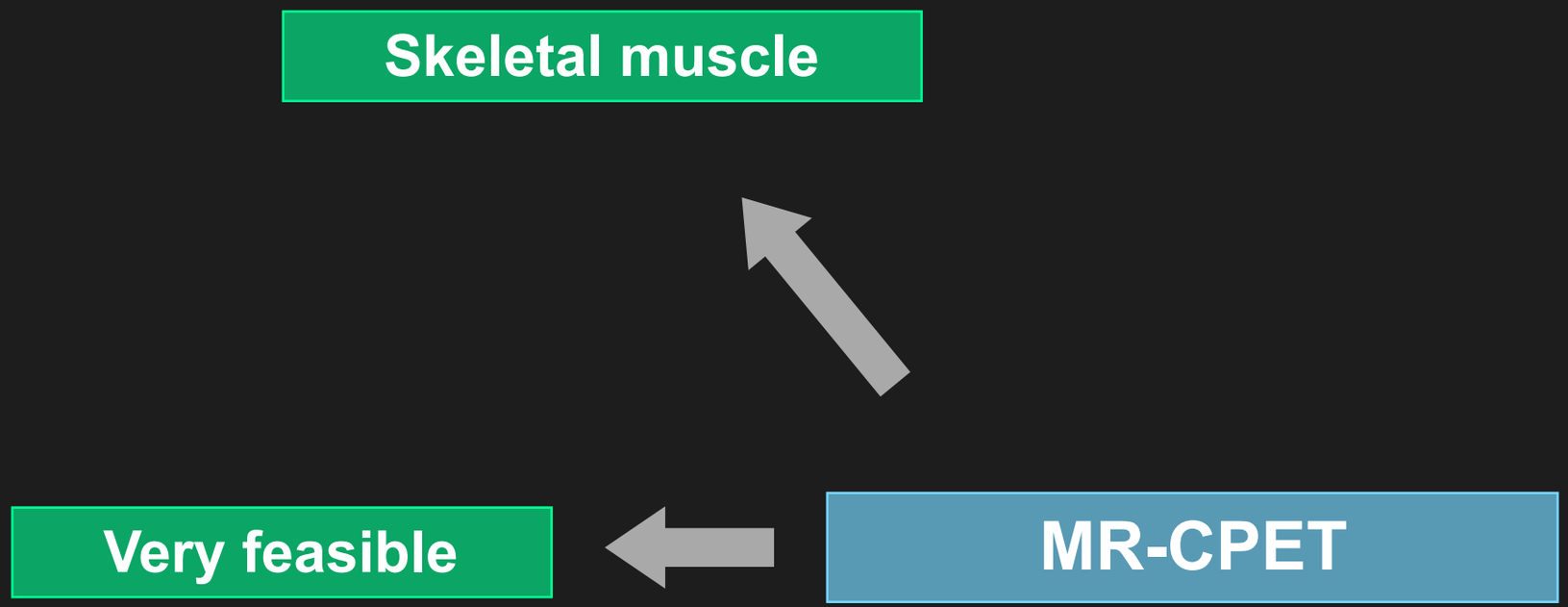
Conclusion

MR-CPET

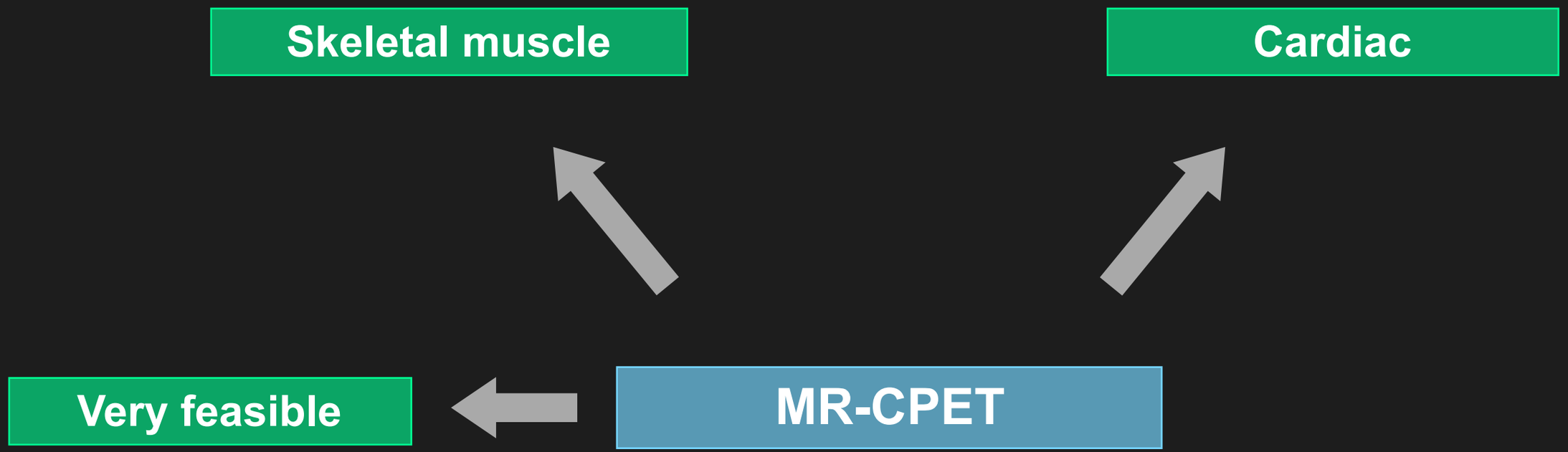
Conclusion

Very feasible ← **MR-CPET**

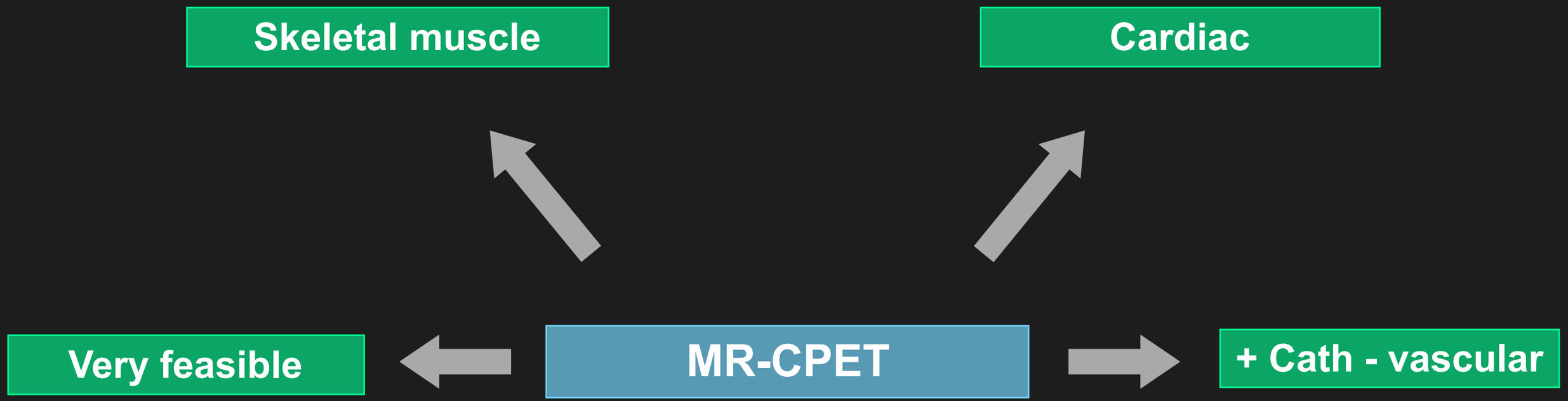
Conclusion



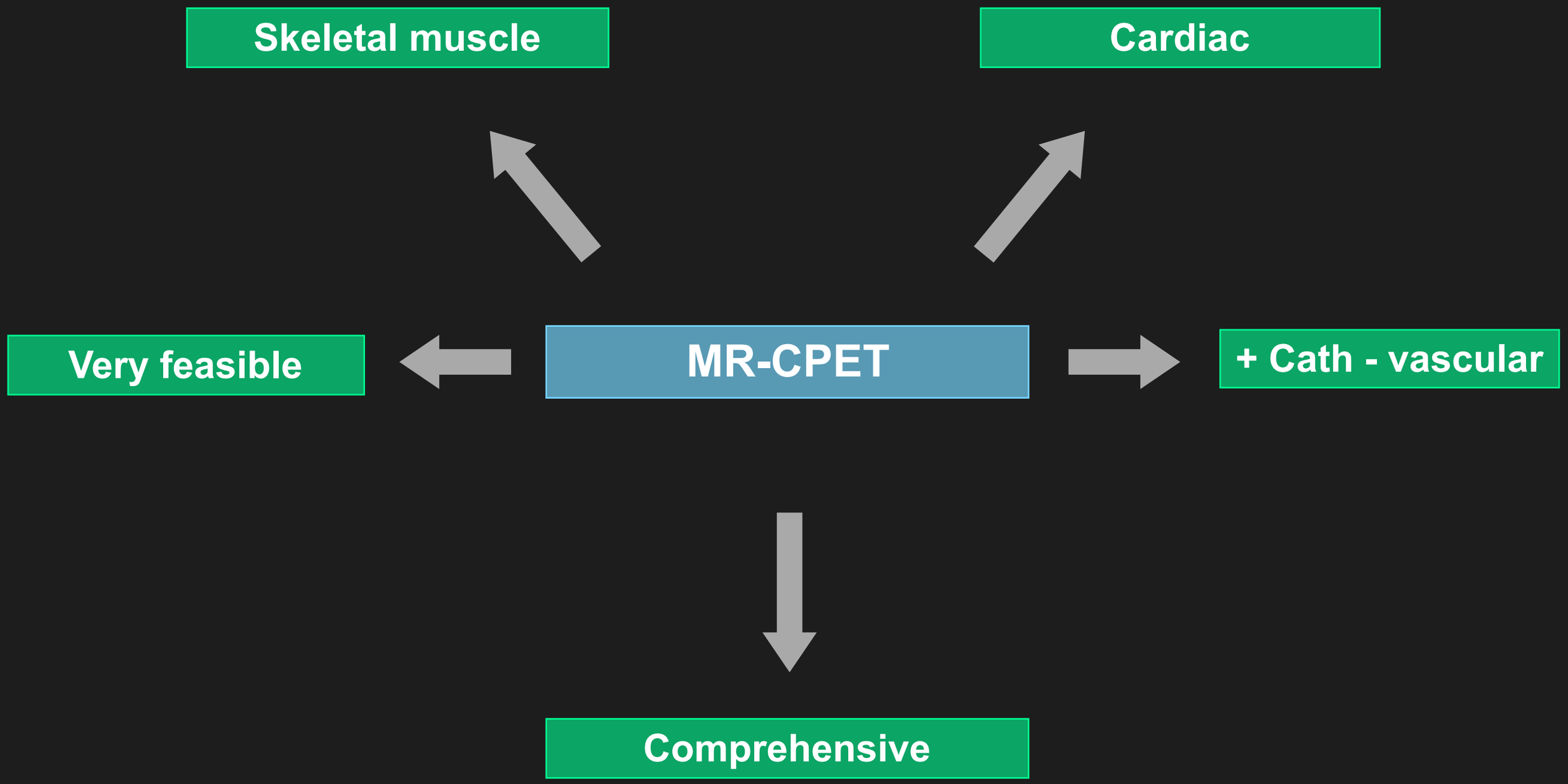
Conclusion



Conclusion


Skeletal muscle
Cardiac
Very feasible
MR-CPET
+ Cath - vascular

Conclusion


Skeletal muscle
Cardiac
Very feasible
MR-CPET
+ Cath - vascular
Comprehensive

This year marks the 50th anniversary of the publication in 1967 of Human Guinea Pigs, an anthology of the cruel, dangerous and often purposeless experiments being carried out – in leading academic medical centres in Britain – on infants, pregnant women, the mentally ill, the old and the dying. Thus, in one typical procedure, the participants were requested to exercise on a standing bicycle with a tight mask fitted over the face while a thin catheter, inserted through a large bore needle in the arm, monitored the pressure within the heart.

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