Going to high altitude with heart disease

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There are very few studies on patients with heart disease going at high altitude.

Real world is...
...not like that
...but like that!

Jungfraujoch 3454 m
However...
63 days at Jungfraujoch (3454m)

~ 5000 subjects/day

315’000 subjects

Only one patient evacuated with ACS
High altitude and coronary artery disease

- Heart rate $\uparrow$
- Myocardial contractility $\uparrow$
- (Afterload $\uparrow$)

**HIGH ALTITUDE**

**Ambient Hypoxia**

$O_2$ demand $\uparrow$
High altitude and coronary artery disease
role of the collateral circulation

Seiler C. Collateral Circulation of the Heart, Springer 2009
High altitude and coronary artery disease

Contraindications

• Unstable Angina

• Symptoms or sign of ischemia < 80 W / 5 MET

• Myocardial infarction / Revascularisation < 3 Months

• Dual platelet antiaggregation + oral anticoagulation

Rimoldi, Sartori et al Prog Cardiovasc Dis 2010;52:512-24
High altitude and coronary artery disease
Preexposure assessment

• In all men > 50y and women > 60y at risk or with known CAD → exercise testing
High altitude and coronary artery disease
Recommendations

• ascent at slow rate at altitude > 2000 m
• increasing sleeping altitude by < 300 m/d
• avoid direct transportation to an altitude > 3000 m
• limit physical activity (< 70% max HR)
• If angina: administer antianginal drugs, descent

Rimoldi, Sartori et al Prog Cardiovasc Dis 2010;52:512-24
High altitude and congestive heart failure

HIGH ALTITUDE

- Cardiac output ↑
- Ambient hypoxia

O₂ demand ↑

Limited exercise capacity

Pulmonary artery pressure ↑

Impaired diastolic filling
High altitude and congestive heart failure
Contraindications

- NYHA > II
- decompensated heart failure < 3 months
- ICD implant./intervent. for ventricular arrhythmia < 3 mo
- Dual platelet antiaggregation + oral anticoagulation

Rimoldi, Sartori et al Prog Cardiovasc Dis 2010;52:512-24
Preexposure assessment

- In all patients transthoracic echocardiography at rest
- Exercise testing (ev. spiroergometry)
- If suspect of pulmonary hypertension → Hypoxia-test
- ev. Holter-ECG
High altitude and congestive heart failure
Recommendations

- Ascent at slow rate > 2000 m (sleeping alt. by < 300 m/d)
- Restriction of salt intake
- If possible monitoring of body weight and fluid retention
- Self adjustment of diuretic dosage
- Maintain unchanged heart failure medications
  (i.e. β-blockers and ACE-I/ARB)

Rimoldi, Sartori et al Prog Cardiovasc Dis 2010;52:512-24
Betablockers at high altitude

Δ low vs. high altitude

Δ peak VO$_2$ (ml/Kg/min)

-20 -15 -10 -5 0 5 10

- Placebo
- Carvedilol
- Nevibolol

p<0.05

Valentini M et al., Cardiovasc Ther 2012;30:240-
Betablockers at high altitude

Valentini M et al., Cardiovasc Ther 2012;30:240-
Betablockers at high altitude

Valentini M et al., Cardiovasc Ther 2012;30:240-
High altitude and arterial hypertension

HIGH ALTITUDE

Sympathetic activation
Vasoconstriction

Ambient hypoxia
Vasodilation
High altitude and arterial hypertension

HIGH ALTITUDE

Sympathetic activation

Ambient hypoxia

Arterial hypertension

Exaggerated Vasoconstriction

Impaired Vasodilation
Antihypertensive Therapy at high altitude: study design

Bilo G et al, Hypertension. 2015;65:1266-
24h ABPM during active treatment

Telmisartan + Nifedipine GITS

Visit 1
Visit 3
Visit 4

SBP [mmHg]

Hours

Bilo G et al, Hypertension. 2015;65:1266-
24h ABPM during placebo

Bilo G et al, Hypertension. 2015;65:1266-
High altitude and arterial hypertension
Contraindications

• BP at rest > 160 / 100 mm Hg
• > 220 mm Hg systolic BP during exercise
• poorly controlled atrial arrhythmia
High altitude and arterial hypertension
Preexposure assessment

• If not well controlled: 24h ambulatory BP measurement
• Exercise testing if exaggerated BP increase suspected
High altitude and arterial hypertension

Recommendations

• Self-monitoring if possible
• if BP controlled: don’t change the therapy
• All antihypertensive drugs are admitted
• Ca\(^{2+}\) -blockers may have additional beneficial effects for HAPE prevention
• \(\beta\) - blockers may limit exercise capacity

Rimoldi, Sartori et al Prog Cardiovasc Dis 2010;52:512-24
Summary

General prerequisites at low altitude

a. Stable clinical condition
b. Asymptomatic at rest
c. Functional class < II
Summary

General recommendations at high altitude

a. Ascent at a slow rate (sleeping alt. < 300 m/d)
b. Avoid overexertion
c. Avoid direct transportation to an alt. > 3000 m
Summary

Absolute contraindications

a. Unstable clinical conditions
   - i.e. unstable angina, symptom or sign of ischemia < 8 W / 5 MET, decompenesated CHF, uncontrolled arrhythmia

b. Major cardiovascular events < 3 months

c. Marked systemic or pulmonary hypertension

d. Cyanotic congenital heart disease
Summary

Preexposure assessment
a. CAD: revascularization > 6 mo -> exercise test
b. Impaired LVEF: echo + exercise test
c. Arterial hypertension: ev. 24h ABPM + exercise
d. Pulmonary hypertension: “Hypoxia-test”
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