

Effects of climbing-wall inclination on trunk muscle activation during various static climbing positions:

Implications for therapeutic climbing



L. Donath¹, C. Grzybowski², H. Wagner²

1 Department of Sport, Exercise and Health, University of Basel, Basel, Switzerland

2 Motion Science, University of Muenster, Muenster, Germany

Background

Background

Methods

Results

Summary

Outlook

... some evidence that therapeutic climbing improves:

- physical function**
- health perception / vitality**
- psycho-social well-being**
- trunk-strength /-flexibility**
- muscle balance (left right)**

...still preliminary, lack of GSP (blinding, randomization, control)

Dittrich M. Eine Pilotstudie zur Wirkung des Therapeutischen Kletterns auf den Gesundheitszustand, den Schmerzzustand, die Funktionsbeeinträchtigung sowie die Rumpfkraft, die Gleichgewichtsfähigkeit und die Beweglichkeit bei chronisch unspezifischem Rückenschmerz. Deutsche Rentenversicherung 2013; 101: S 515–S 517

Engbert K, Weber M. The effects of therapeutic climbing in patients with chronic low back pain: a randomized controlled study. Spine 2011; 36 (11): 842–849 07

SchinhanM, Castellucci C, Pieber K et al. Klettern als Therapieoption bei tieflumbalem chronischem Schmerzsyndrom. Sport-Orthopädie – Sport-Traumatologie 2012; 28 (2); 112-113

Heitkamp HC, Weber S, Rapp W et al. Auswirkungen eines Klettertrainings auf den konvexen Teil der Rückenmuskulatur bei jugendlichen Skolioitikern. Dtsch Z Sportmed 2007; 7/8: 244

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(Trunk) muscle activity studies are lacking

Modulation/variation of trunk muscle activity:

- **hip position**
- **Number of fixed holds (ipsilat. RA, EO, MF)**
- **Wall inclination and static Positions unclear**

Participants

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- **13 sport students (no climbing experience)**
- **7 males / 6 females**
- **Age: 27 (SD: 3) years**
- **Weight: 70 (10) kg**
- **Height: 175 (8) cm**
- **BMI: 22.3 (1.9) kg/m²**
- **No acute or chronic diseases**

Experimental set up

Background

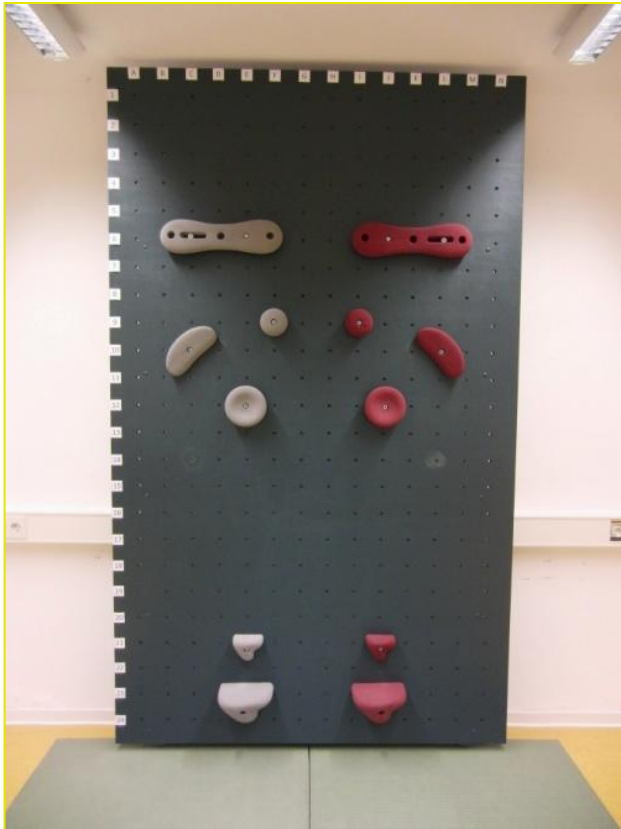
Methods

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2.5m × 1.5m; Inclination 0 to 18°



Experimental set up

Background

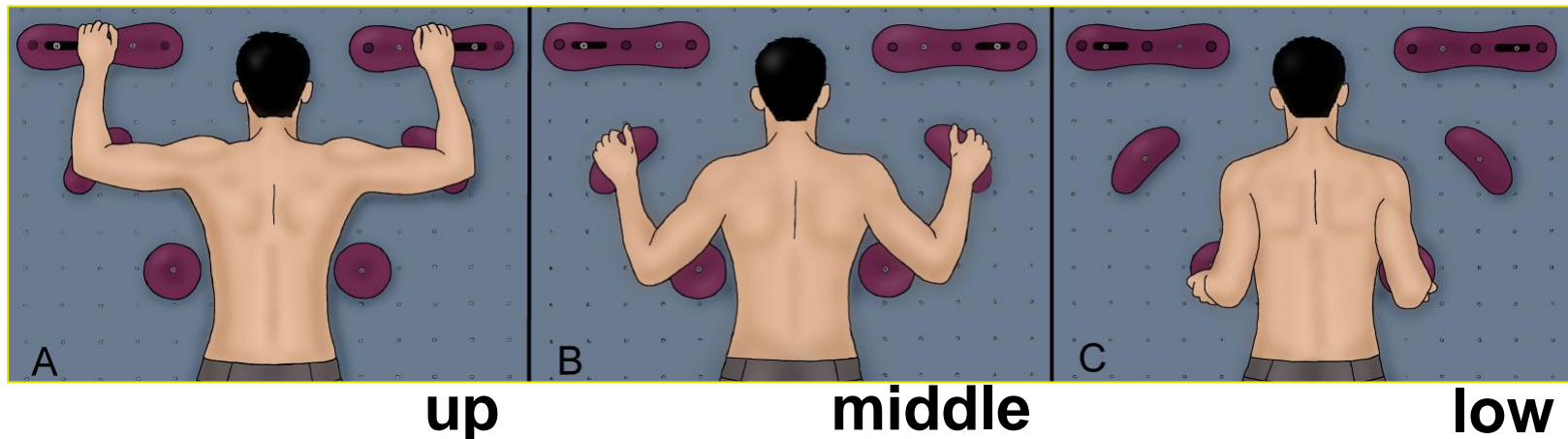
Methods

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Climbing positions



... climbing positions: up, middle & low

... starting position, lift right foot / lift right hand

... 0° , 4° , 8° , 12° , 15° , 18°

$3 \times 3 \times 6$
conditions/tasks

Placement of electrodes

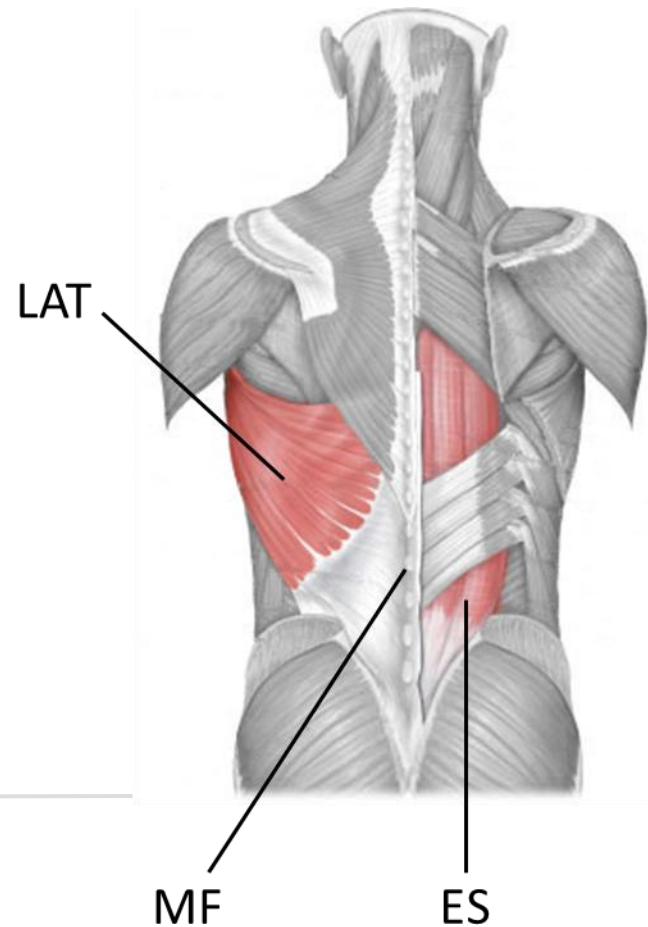
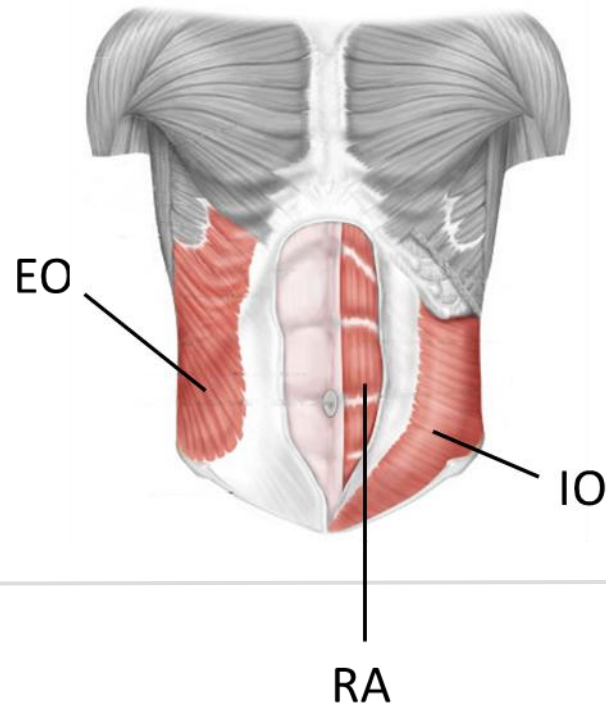
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EMG application

Background

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- amplification: 2500-5000
- Sample rate: 2000 Hz
- Hydrogel Ag/AgCl one-way electrodes (Arbo)
- Interelectrode distance: 25mm
- Skin preparation according to SENIAM (Hermens et al. 1999)
- Positioning according to literature (Criswell 2010 (OE, ES), Ng et al. 1998 (RA, OI, MF), de Seze & Cazalets 2008 (LAT))

Exemplary data plot

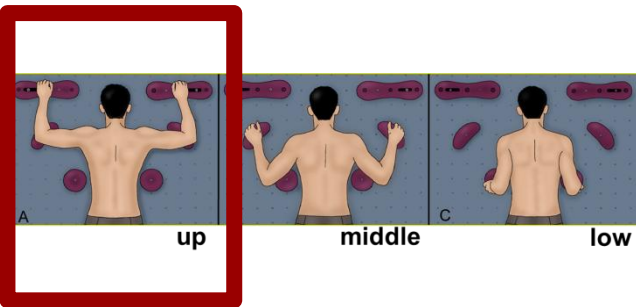
Background

Methods

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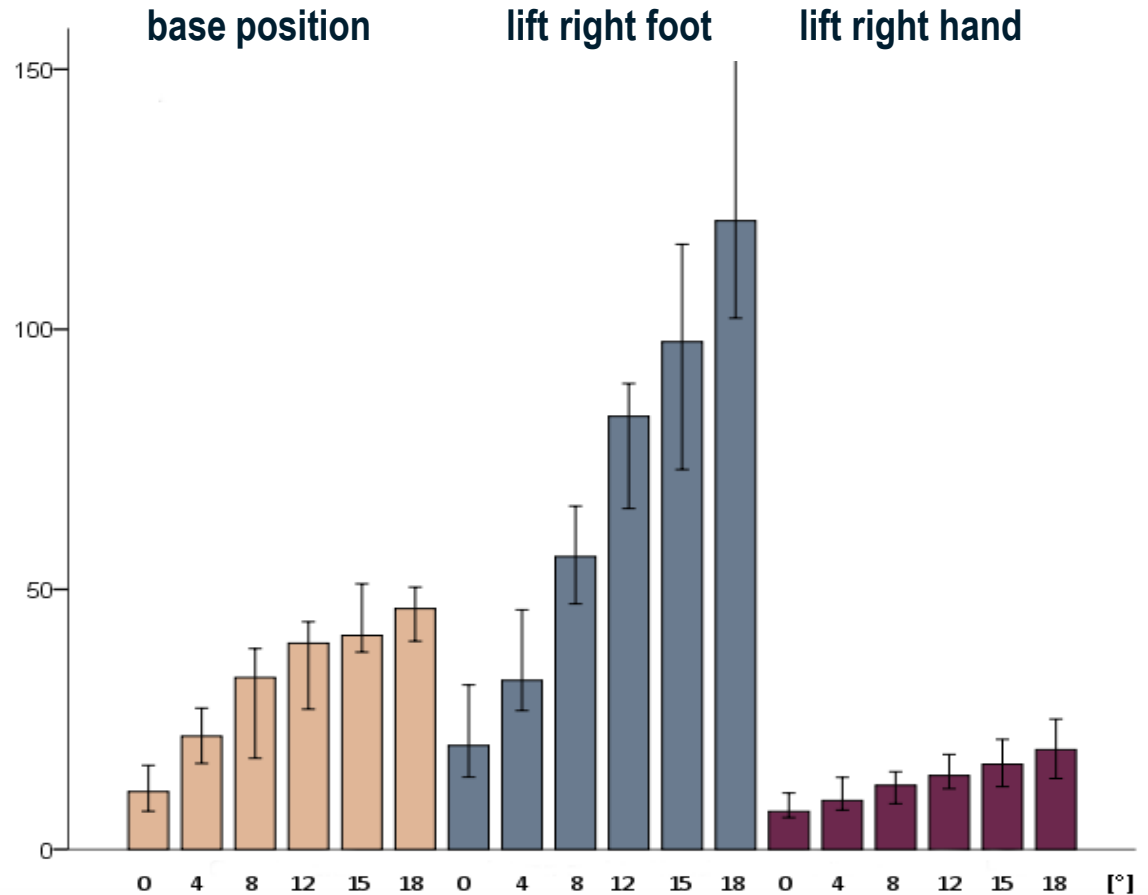
Summary

Outlook



EMG [μ V]
Erector spinae (left)
Position A

Median (95% CI)



Exemplary data plot

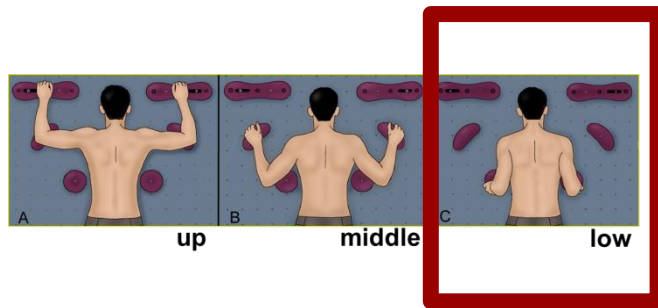
Background

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Outlook

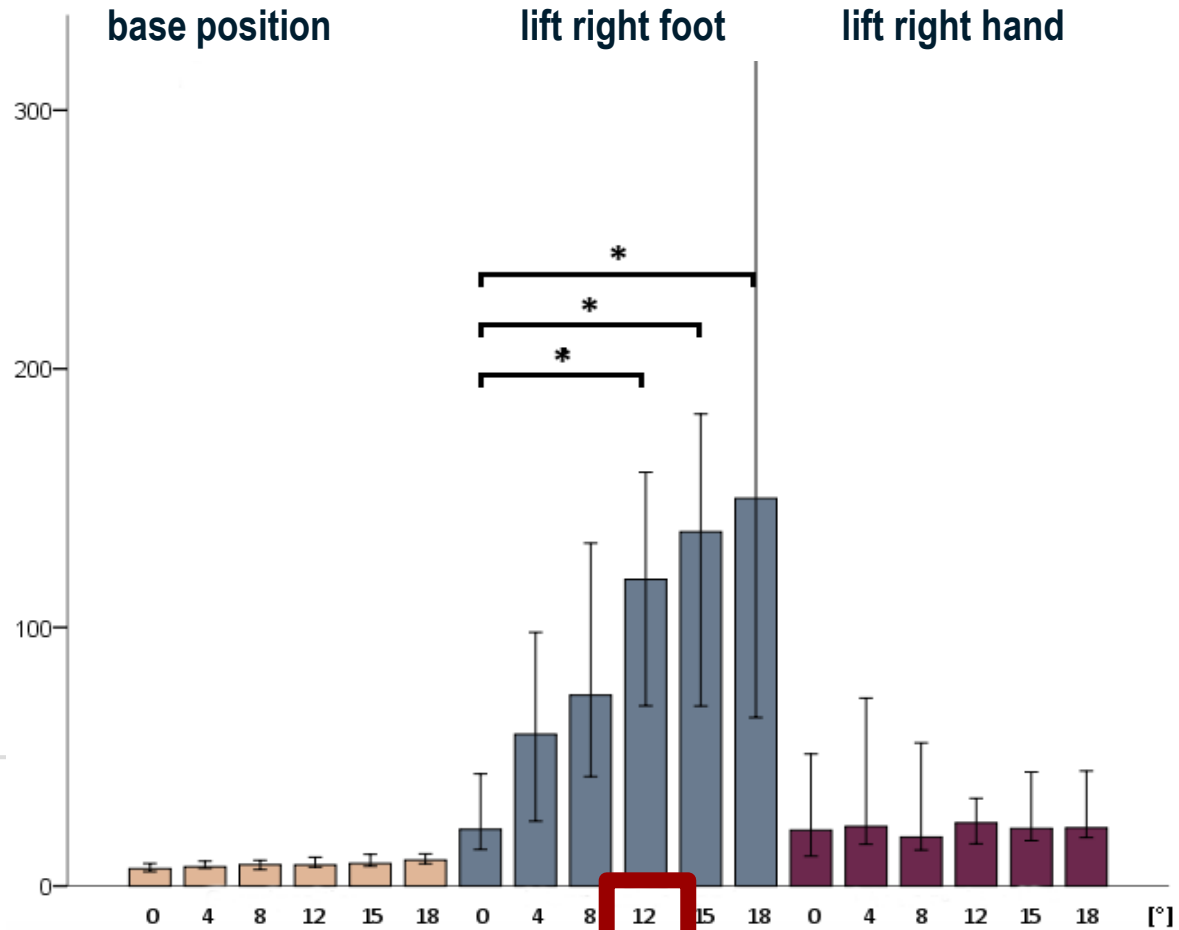


EMG [μ V]

Obliquus externus (right)

Position C

Median (95% CI)



Exemplary data plot

Most

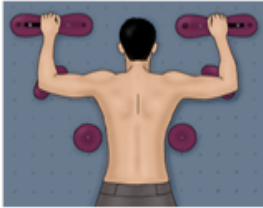
Background

Methods

Results

Summary

Outlook

position	left			muscle	right		
	base position	lifting hand	lifting foot		base position	lifting hand	lifting foot
	≥ 12	≥ 12	≥ 12	erector spinae	≥ 12	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 12	multifidus	≥ 12	≥ 12	≥ 12
	18	≥ 12	n.s.	latissimus	18	≥ 15	≥ 12
	n.s.	≥ 12	12 / 18	external oblique	n.s.	≥ 12	≥ 15 ¹
	n.s.	≥ 12	n.s.	internal oblique	n.s.	18	n.s.
	12 / 18	≥ 12	≥ 12	rectus abdominis	12 / 18	≥ 12	n.s.

Exemplary data plot


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position	left			muscle	right		
	base position	lifting hand	lifting foot		base position	lifting hand	lifting foot
	≥ 12	≥ 12	≥ 12	erector spinae	≥ 12	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 12	multifidus	≥ 15	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 8	latissimus	≥ 15	≥ 15	≥ 12
	n.s.	≥ 12	12 / 18	external oblique	n.s.	≥ 12	n.s.
	n.s.	≥ 12	n.s.	internal oblique	n.s.	18	≥ 15
	≥ 12	≥ 12	≥ 12	rectus abdominis	n.s.	≥ 12	≥ 15

Exemplary data plot

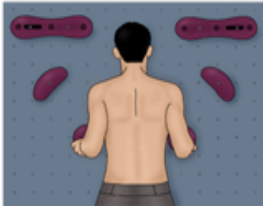
Background

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Outlook

position	left			muscle	right		
	base position	lifting hand	lifting foot		base position	lifting hand	lifting foot
	≥ 15	≥ 12	≥ 12	erector spinae	≥ 15	≥ 12	≥ 12
	18	≥ 12	≥ 12	multifidus	n.s.	≥ 12	≥ 12
	≥ 12	≥ 12	n.s.	latissimus	≥ 15	18	≥ 12
	≥ 15	≥ 12	≥ 15	external oblique	18	≥ 12	n.s.
	n.s.	≥ 12	n.s.	internal oblique	18	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 12	rectus abdominis	≥ 12	≥ 12	≥ 12

Significance and inclination

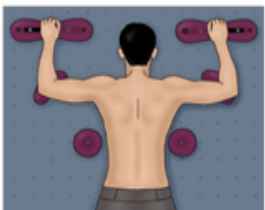
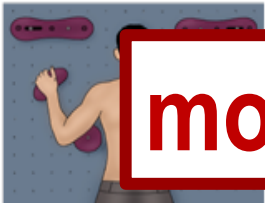
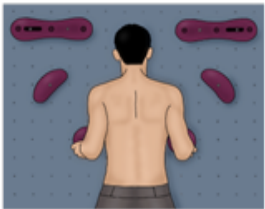
Background

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Outlook

position	left			muscle	right		
	base position	lifting hand	lifting foot		base position	lifting hand	lifting foot
	≥ 12	≥ 12	≥ 12	erector spinae	≥ 12	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 12	multifidus	≥ 12	≥ 12	≥ 12
	18	≥ 12	n.s.	latissimus	18	≥ 15	≥ 12
	n.s.	≥ 12	12 / 18	external oblique	n.s.	≥ 12	≥ 15 ¹
	n.s.	≥ 12	n.s.	internal oblique	n.s.	18	n.s.
	12 / 18	≥ 12	≥ 12	rectus abdominis	12 / 18	≥ 12	n.s.
	≥ 12	≥ 12	≥ 12	erector spinae	≥ 12	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 12	rectus abdominis	n.s.	≥ 12	≥ 15
	≥ 15	≥ 12	≥ 12	erector spinae	≥ 15	≥ 12	≥ 12
	18	≥ 12	≥ 12	multifidus	n.s.	≥ 12	≥ 12
	≥ 12	≥ 12	n.s.	latissimus	≥ 15	18	≥ 12
	≥ 15	≥ 12	≥ 15	external oblique	18	≥ 12	n.s.
	n.s.	≥ 12	n.s.	internal oblique	18	≥ 12	≥ 12
	≥ 12	≥ 12	≥ 12	rectus abdominis	≥ 12	≥ 12	≥ 12

mostly at least 12° inclination needed

Discussion

Background

Methods

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Outlook

- I. Inclination affects muscle activity (MA) when hand lifted**
- II. IO and EO less MA changes when lifting foot in base position**
- III. Base position lifted foot needed**
- IV. Increasing relevance for hand when inclination increases
(force transfer 60% via hands from $\geq 10^\circ$)**
- V. MA cut point around 12° (between 8° to 12°)**

Limitations

Background

Methods

Results

Summary

Outlook

- **Healthy subjects**
- **No disease background**
- **Electrode placement**
- **Crosstalk contribution alterations during inclination**
- **Only right side lifted (no asymmetries presumed)**

Conclusion (Outlook)

Background

Methods

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Summary

Outlook

- I. **Static exercise appropriate to work on erect posture**
- II. **Tailored climbing exercise to activate certain trunk muscles**
- III. **What about dynamic climbing?**

Thank you for your attention



lars.donath@unibas.ch

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