



HAL
open science

Biomechanics of Rock Climbing

Xavier Hugues, Violaine Cahouet, Franck Quaine

► **To cite this version:**

Xavier Hugues, Violaine Cahouet, Franck Quaine. Biomechanics of Rock Climbing. Ecole d'été Science 2024, Jun 2023, Dinard, France. 2023. hal-04206187

HAL Id: hal-04206187

<https://hal.science/hal-04206187>

Submitted on 15 Sep 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

INTRODUCTION & ISSUES

Climbing has undergone significant advancements in recent times, characterized by increasingly challenging outdoor ratings (up to 9c) and unprecedented speed records (4.90 seconds). The sport has gained tremendous excitement, especially with its inclusion in the Olympic Games (2021). The aim of this thesis will be to develop a musculo-skeletal model of the climber to study his motor strategy and his muscle coordination.

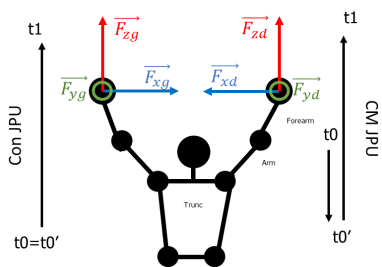
BIOMECHANICS : COORDINATION

Participants 17 climbers (7c French route grade)

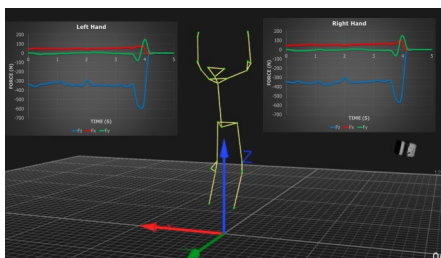
How do lower & upper limbs participate to the movement of Dyno in sport climbing?



How does the countermovement affect the arm-jump performance in sport climbing?



Typical qualisys model with hand forces reference and the two form's of Jump Pull-Up



Typical Qualisys (QTM) model which hand forces displayed

MUSCULOSKELETAL MODEL

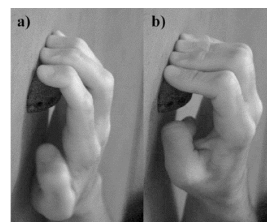


HYPOTHESIS

- Elastography to assess physiological parameter**
 - PCSA—Physiological cross-sectional area
 - Young Modulus—muscle contraction
 - Finger pulley thickness

RELATED ISSUES

- Muscle coordination**
 - Crimping tasks—Finger Force \neq Muscle activation



Slope (a) and crimping (b) tasks [1]

- Training follow-up**

BFR—Blood Flow Restriction (Titouan Perrin, PhD student)

High load training



VS

Low load training



SYNTHESIS

The utilization of the instrumented wall provides us with an opportunity to enhance our understanding of various joint coordination strategies. Preliminary tests conducted on the dyno movement have yielded highly promising results [2-4]. Moreover, by employing elastography, we will gain a deeper insight into diverse muscular coordination strategies during different gripping tasks, ultimately leading to improvements in existing models [5].

BIBLIOGRAPHY

[1] A. M. Amca, L. Vigouroux, S. Aritan, and E. Berton, "Effect of hold depth and grip technique on maximal finger forces in rock climbing," <https://doi.org/10.1080/02640414.2012.658845>.
 [2] G. Laffaye, J.-M. Collin, G. Levernier, and J. Padulo, "Upper-limb Power Test in Rock-climbing," *Int. J. Sports Med.*, vol. 35, no. 08, pp. 670–675, Feb. 2014, doi: 10.1055/s-0033-1358473.
 [3] N. Draper et al., "Sport-specific power assessment for rock climbing," *J. Sports Med. Phys. Fitness*, vol. 51, no. 3, pp. 417–425, Sep. 2011, Accessed: Feb. 20, 2023.
 [4] B. Van Hooren and F. Bosch, "Influence of muscle slack on high-intensity sport performance: A review," *Strength Cond. J.*, vol. 38, no. 5, pp. 75–87, 2016, doi: 10.1519/SSC.0000000000000251.
 [5] L. Vigouroux, F. Quaine, A. Labarre-Vila, and F. Moutet, "Estimation of finger muscle tendon tensions and pulley forces during specific sport-climbing grip techniques," *J. Biomech.*, vol. 39, no. 14, pp. 2583–2592, 2006, doi: 10.1016/j.jbiomech.2005.08.027.

GREATINGS

Supervisors : Franck Quaine, Julien Brugniaux, Violaine Cahouet
 Colleagues : Romain Rogue, Sophie Oudar, Silvain Gerber & Arthur Thepault
 Claire Quéinec for her enthusiasm

