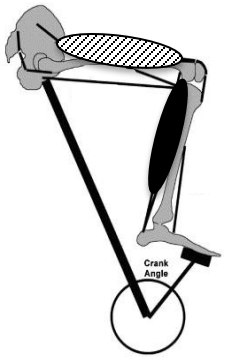
UNIVERSITÉ DE NANTES

direct energie PRO CYCLING TEAM

ANAPACy Analyse et optimisation de la performance

Laboratoire Motricité - Interactions - Performance EA 4334 Nantes - Le Mans

Muscle-tendon behaviour during sprint in road cyclists : Effect of the force-velocity condition

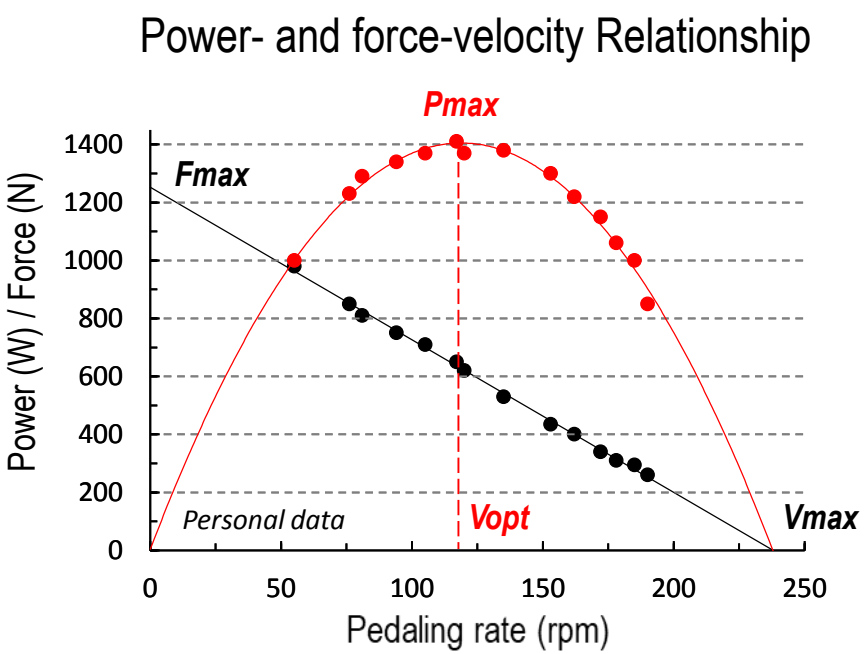


Maxime Robin, *Hugo Hauraix, Antoine Nordez, Sylvain Dorel*

Laboratory "Movement Interactions Performance" - EA 4334 - NANTES

www.mip.univ-nantes.fr

Force- and Power-velocity Relationship in pedalling : measurement of muscle properties of the lower limbs



- **Pmax** and **Vopt** = Performance factor

Vandewalle et al. 1987, Driss et al. 2002, Dorel et al. 2010.

- **Biomechanical constraints related to this multi-joint task**

- **Specific coordination of different muscles (mono- and bi-articular)**

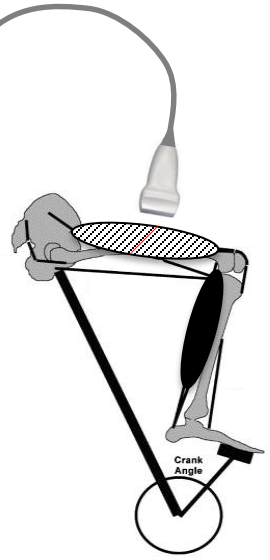
Ultrasound allowed to better understand the muscle behaviours and determine the contributions of tendinous and contractile structures

It has been used to study different tasks like running and jumping

Ishikawa et al. 2007, Kurokawa et al. 2001

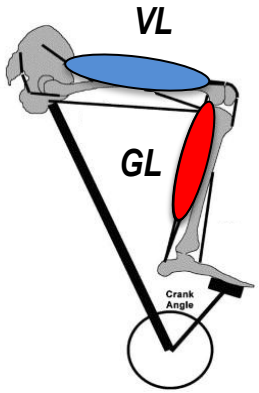
Some studies in pedaling (submaximal conditions)

Muraoka et al. 2001, Brennan et al. 2018

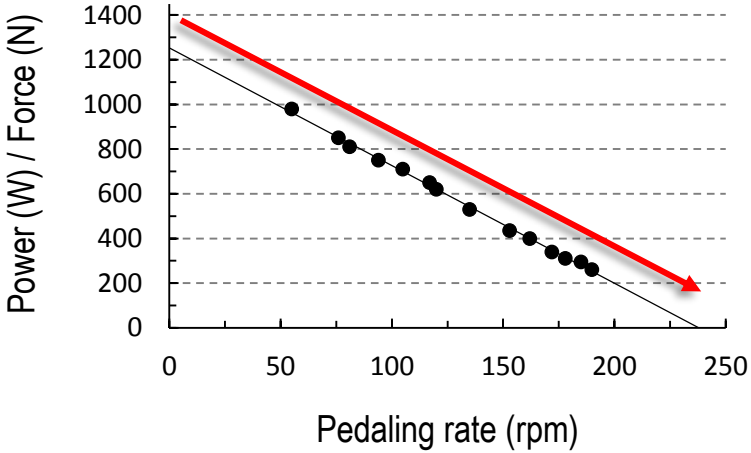


Objectives

- **Describe fascicle-tendon behaviours of a mono-articular muscle : vastus lateralis (VL) and a bi-articular muscle : gastrocnemius lateralis (GL) during maximal sprint cycling**



- **Investigate whether both fascicle and muscle-tendon unit shortening velocities are influenced by the force-velocity condition**

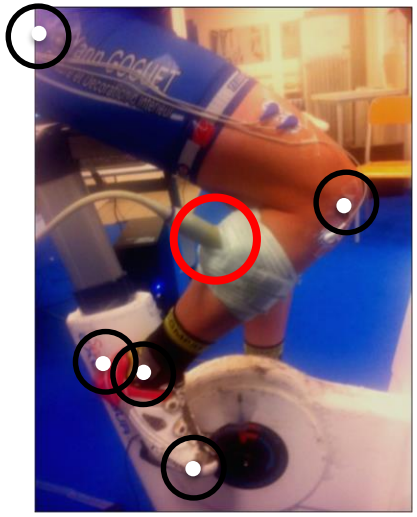


Experimentation

Subjects :

11 well trained cyclists (13 000 kms/year): 21,9 ± 4,5 years, 177,5 ± 4,7 cm; 67,3 ± 4,6 kg

Matériels :



LODE ergometer

Kinematic : 120Hz
Knee and ankle angles

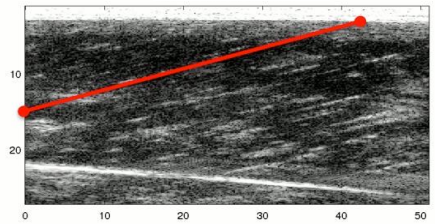
MTU length

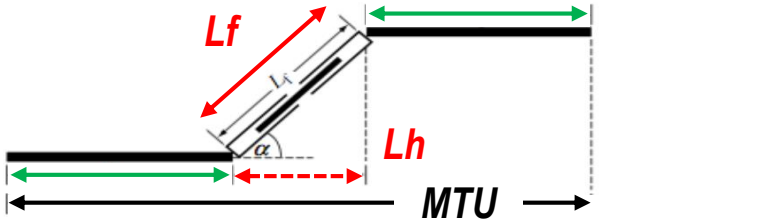
Grieve et al 1978, Visser et al 1980

Ultrafast ultrasound
500 - 2000 Hz

Fascicle length

Litchwark et al. 2016

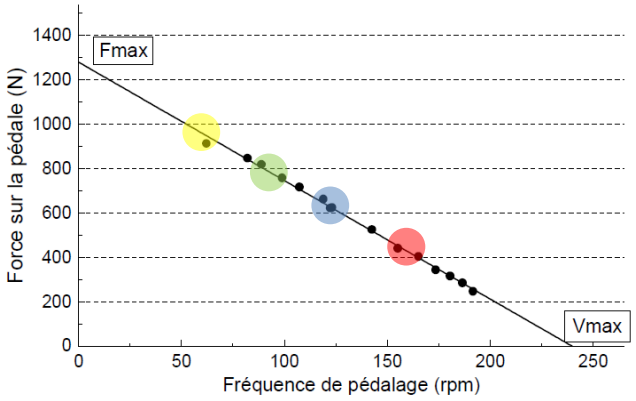


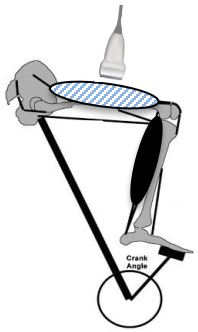


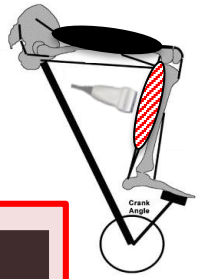
Muscular model *Fukunaga et al. 2001*

Protocol

Single session.





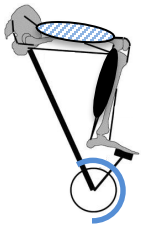


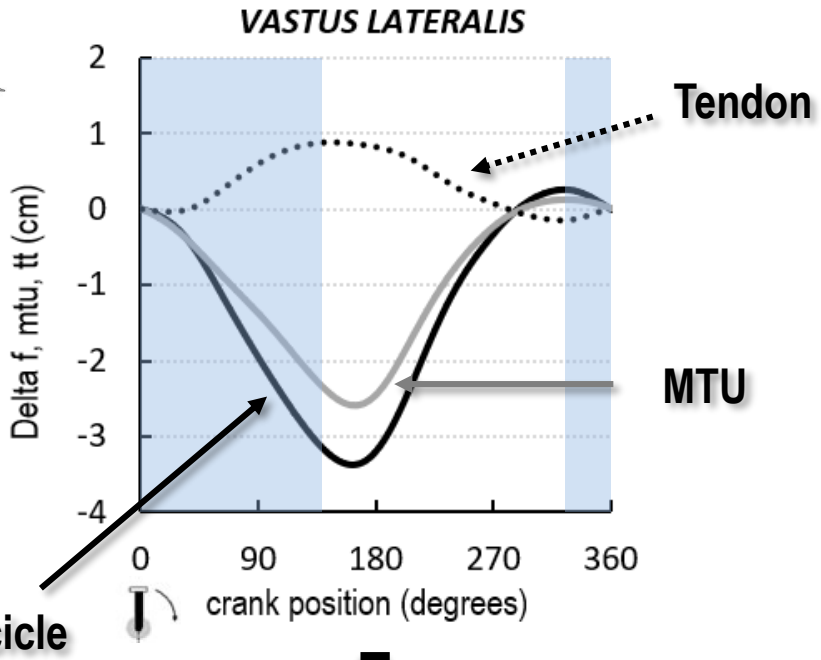
Antropometric measurements
Lode position
Probe on VL
Warm-up 10 minutes
2 *minutes rest*
2' 150w
2' 300w
2 *minutes rest*
Isokinetic sprint 60
5 *minutes rest*
Isokinetic sprint 90
5 *minutes rest*
Isokinetic sprint 120
5 *minutes rest*
Isokinetic sprint 160
5 *minutes rest*
Isokinetic sprint
5 *minutes rest*
Isokinetic sprint
Probe on GL

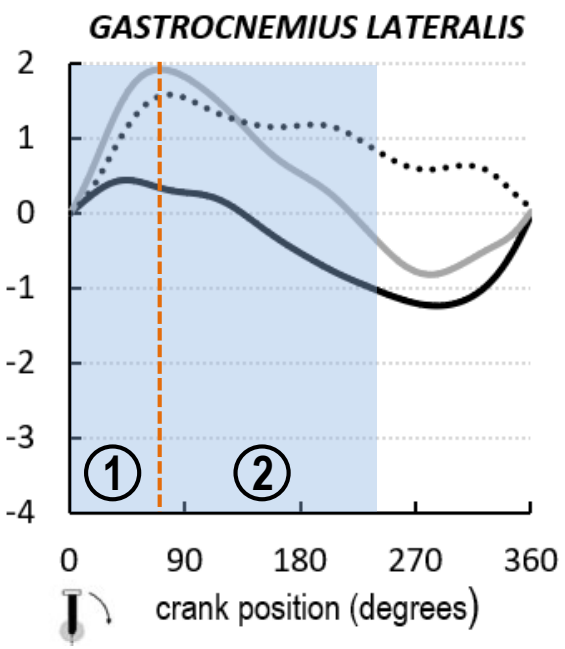
Two conditions were randomly repeated to check the reproducibility

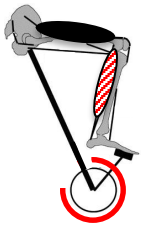
Behaviour of the different components of the muscle

Sprint at 120 rpm









A unique phase during which both MTU and fascicle shorten

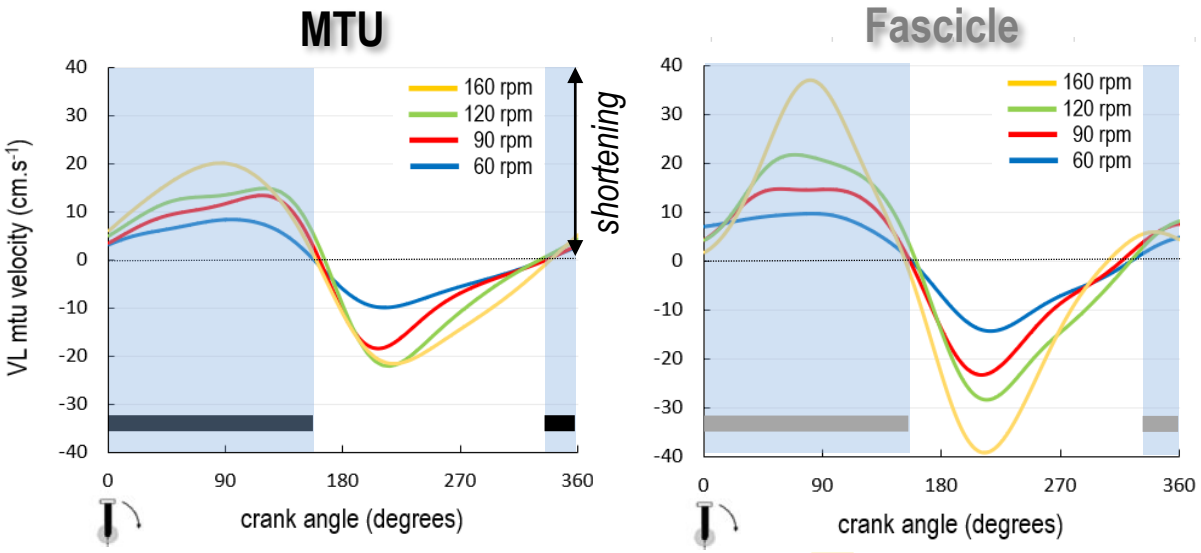
Muraoka et al. 2001

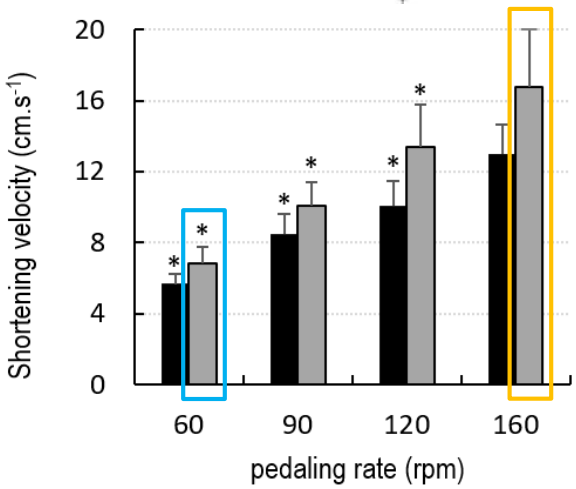
Concentric behaviour

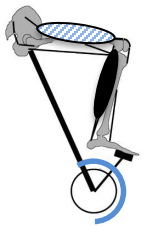
More complex behaviour

MTU: Lengthening
Fascicle: Quasi-isometric

Effect of the force-velocity condition ?



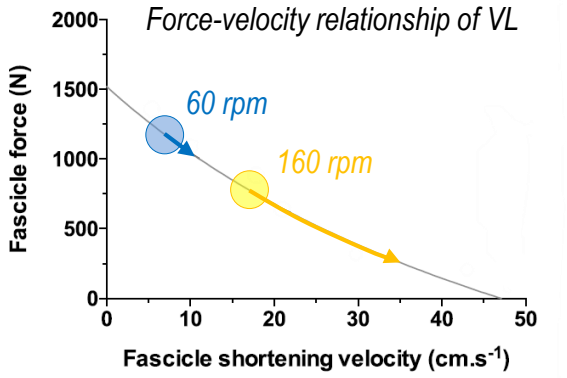




Vastus lateralis

- ↗ Mean shortening velocity (MTU and Fascicle)
- ↗ Peak shortening velocity (MTU and Fascicle)

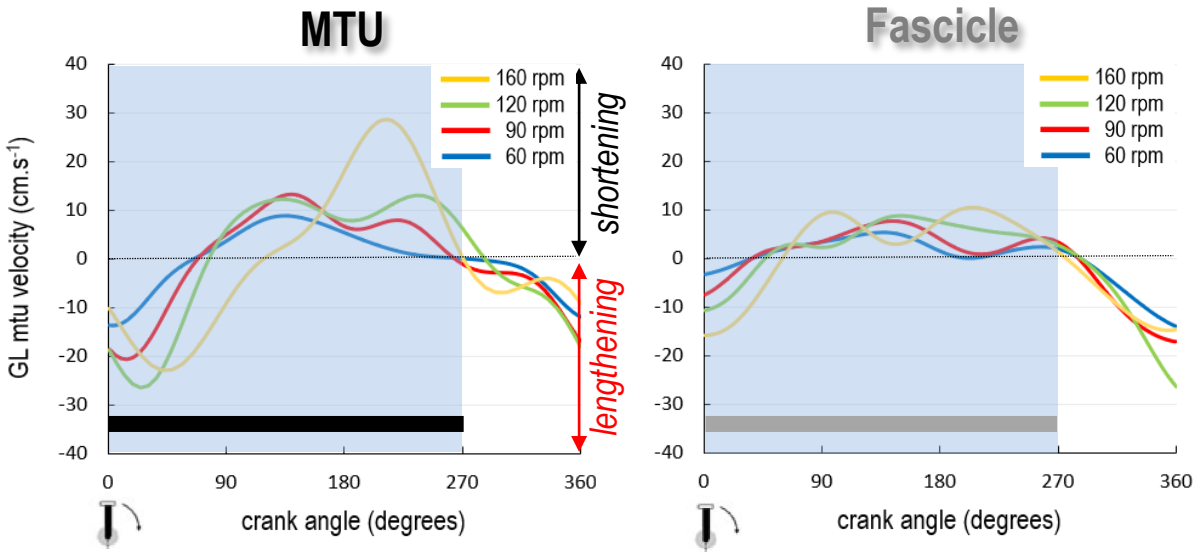
Brennan et al. 2018

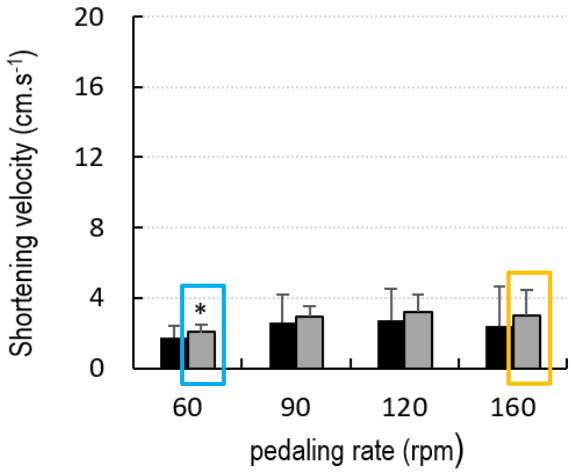


Hauraix et al. 2016

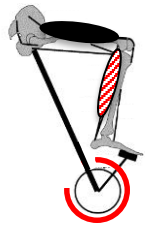
** for significant differences between the considered condition and the direct higher condition*

What influence of the force-velocity condition ?





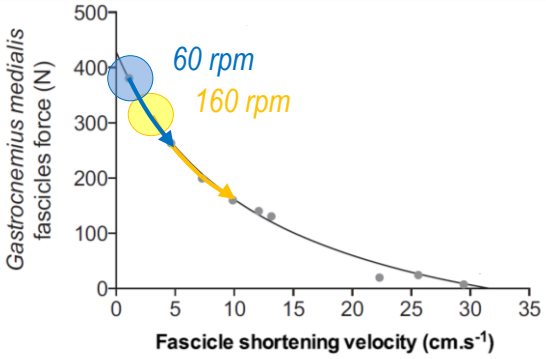
** for significant differences between the considered condition and the direct higher condition*



Gastrocnemius lateralis

- Slight effect of pedaling rate (decrease ankle range of motion)
- Fascicle = low velocity

Force-velocity relationship of GL



Hauraix et al. 2015

To conclude…

VL and GL have different muscle-tendon behaviours

VL : Knee extensor

Concentric behaviour

The force-velocity condition influence the shortening velocities (MTU and fascicle)

GL : Knee and plantar flexors

More complex behaviour

Eccentric - Concentric mode (MTU) : stretching of elastic structures (0 - 70°)

Quasi-isometric mode (Fascicle) : Low fascicle shortening velocity

Slight effect of pedalling rate

Perspectives :

- Orientating for strength training
- What behaviour in standing position?
- What effects of training ?

Thank you for your attention

MAXIME ROBIN

Laboratoire Motricité Interactions Performance - EA 4334 - NANTES

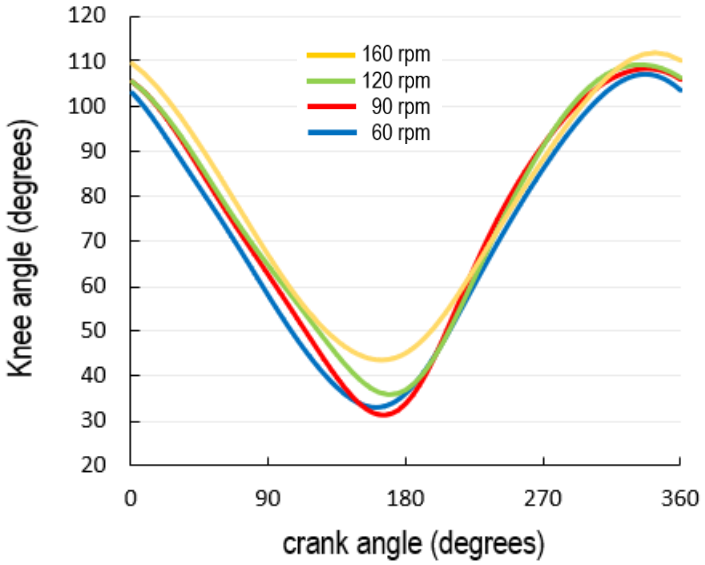
direct energie

PRO CYCLING TEAM

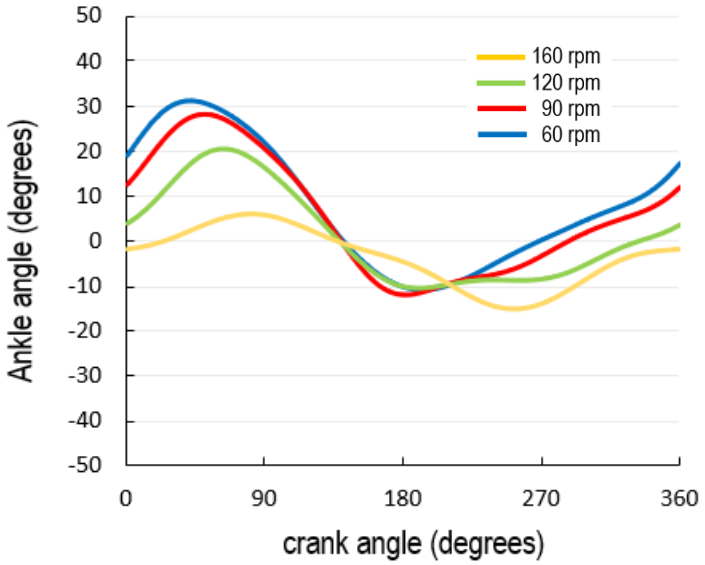
Laboratoire
Motricité - Interactions - Performance
EA 4334 Nantes - Le Mans

Data angle

KNEE



ANKLE



KNEE : to 75 at 65° = -10°

ANKLE : to 44 at 19° = -25°

High velocity sprint = decreased range of motion