



Etiology of “Contraction Induced Muscle Injury”

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Muscle contractions

- Support in position
- Miometric or shortening contraction
- Acceleration in movement
- Pliometric or lengthening contraction
- Deceleration in movements

Contraction-induced muscle injury

- Typically occur following eccentric contractile activity
- Eccentric-induced muscle injury (damage)
 - walk or running, especially downhill
 - lowering heavy object
 - landing from a jump
- Brakes, slow limb movement, shock absorbers,
- Highest muscle forces (2-fold > isometric)

General features

- disruption of intracellular muscle structure (immediate)
- prolonged muscle weakness and dysfunction (immediate)
- muscle soreness (delayed)
- inflammation (delayed)
- several weeks for recover

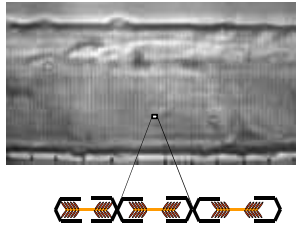
Why?

Popping sarcomere hypothesis

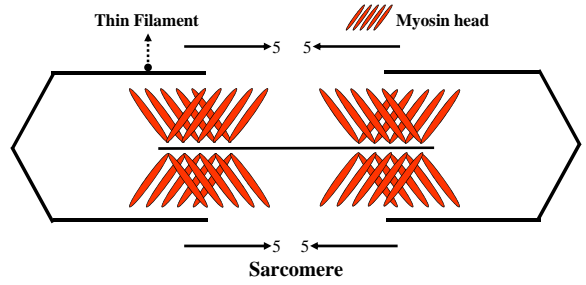
<David Morgan, 1990>



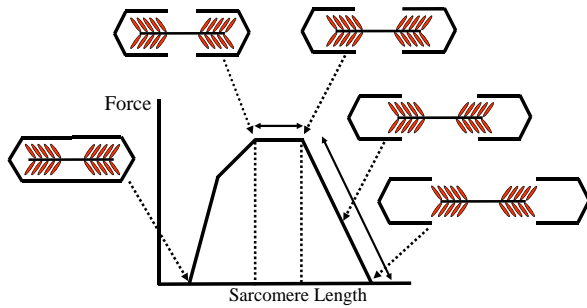
Sarcomere



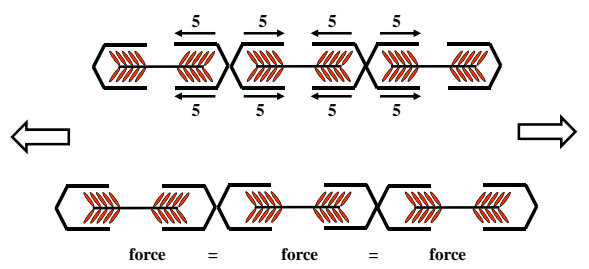
Cross-bridge sliding



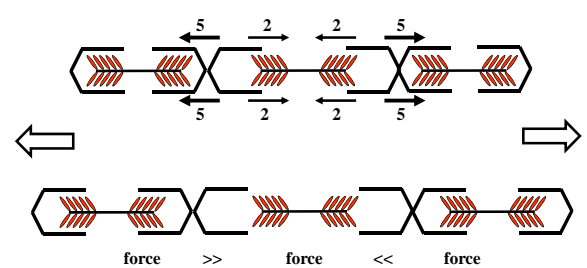
Length-tension relationship



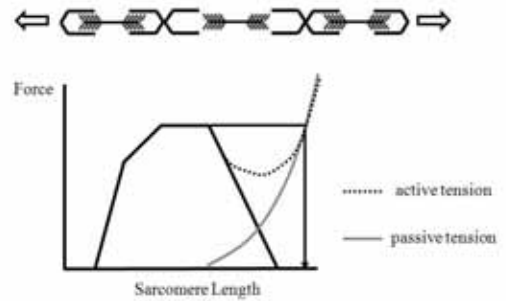
Under homogeneous length



Under heterogeneous length



Under heterogeneous length



Summary of Popping sarcomere theory



- 1) Sarcomere length heterogeneity
- 2) Longest (weakest) sarcomere extended onto descending limb
- 3) This sarcomere is stretched more rapidly & widely than other sarcomeres
- 4) Weaker sarcomere takes up most of stretch
- 5) Structural distortion → propagated longitudinally & radially within myofibril
- 6) Myofilaments fail to re-interdigitate after stretched
- 7) Dysfunctional sarcomere

Sarcomere Length Heterogeneity?



Why?

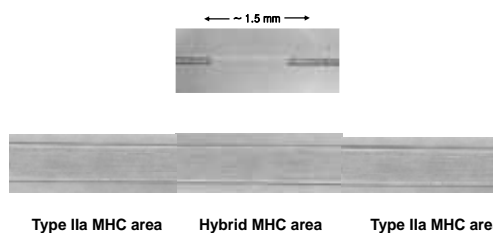
Fiber type determinant 'Myosin Heavy Chain'



	Slow-twitch fiber (type I MHC)	Fast-twitch fiber (type IIa, (or IIx) MHC)
Force	100%	130%
Shortening	100%	300-800%
Velocity	100%	Much higher
Power	100%	Much higher
Fatigue	Much higher	100%

Hybrid Fiber

: two or more MHC isoform in single muscle fiber



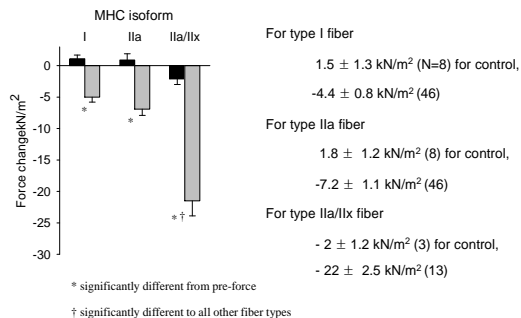
Study 1

Calcium-activated force of human muscle fibers following a standardized eccentric contraction

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to investigate the force change of human skinned muscle fiber subjected to a single in vitro eccentric contraction, and compared how these force deficits were related to fiber MHC isoform content

Force change after a standardized eccentric contraction





Study 2



*"Role of myosin heavy chain polymorphism
in differential susceptibility of muscle fibers to eccentric contraction"*

to test **two hypotheses** by evaluating the susceptibility of fibers expressing the **full range of mammalian skeletal muscle MHC isoform**, including type I, IIa, IIx, IIb fibers and their major hybrid combination, type I/IIa, IIa/IIx, and IIx/IIb fibers

Force change following eccentric treatment

MHC (No of fibers)	pre-force	pre to post force change	
	kN/m ²	kN/m ²	%
I (24)	109 ± 3	-5.1 ± 0.4	-4.8 ± 0.5
I/IIa (7)	118 ± 7	-18.6 ± 1.4	-15.5 ± 1.2
IIa (27)	117 ± 3	-5.3 ± 0.4	-4.5 ± 0.5
IIa/IIx (5)	136 ± 11	-18.1 ± 2.3	-13.4 ± 1.5
IIx (34)	119 ± 2	-5.1 ± 0.4	-4.5 ± 0.5
IIx/IIb (11)	124 ± 2	-18.0 ± 1.2	-14.4 ± 0.9
IIb (24)	120 ± 2	-5.9 ± 2.5	-4.7 ± 0.7

Summary

- 1) Irregular sarcomere length
- 2) Popping sarcomere when external force applied
- 3) Disruption of intracellular muscle structure
- 4) Activation (EC Coupling) impairment
- 5) Inflammation, DOMS, Dysfunction