Protein syntese og degradering under styrketræning

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Resistance exercise increases AMPK activity and reduces 4E-BP1 phosphorylation and protein synthesis in human skeletal muscle

J Physiol 576.2 (2006) pp 613–624

Hans C. Dreyer[2,4], Satoshi Fujita[2], Jerson G. Cadenas[2], David L. Chinkes[3], Elen and Blake B. Rasmussen[1,4]

Design:

Muskelbiopsier før, lige efter, 1 og 2 timer efter styrketræning.
Målemetode; stabile isotoper

Træning; 10x10 knæekstentioner (3 min. mellem sæt, 70% af 1RM)

Konklusion: protein syntese ned under træning, og op allerede 1 time efter.

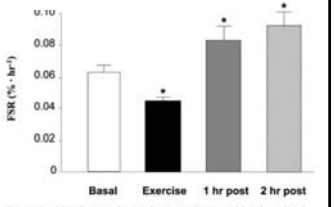


Figure 2. Muscle protein synthesis as expressed by the mixed muscle fractional synthetic rate (FSR) before, during, and after a bout of resistance exercise
Data are expressed as means ± S.E.M., $n = 11$. *Significantly different from basal ($P < 0.05$).

Ekstra information: . Furthermore, the increase in muscle protein synthesis during early post-exercise recovery is associated with a reduction in eEF2 phosphorylation, and an increase in PKB, mTOR and S6K1 phosphorylation.

Essential amino acid and carbohydrate ingestion before resistance exercise does not enhance postexercise muscle protein synthesis

J Appl Physiol 106: 1730–1739, 2009.

Satoshi Fujita,[1] Hans C. Dreyer,[2,3] Micah J. Drummond,[2,3] Erin L. Glynn,[3] Elena Volpi,[1] and Blake B. Rasmussen[2,3]

Design:

Fastende gruppe (n=11) og EAA+CHO gruppe (n=11).
Proteinsyntese før og efter styrketræning.

Muskelbiopsier før, lige efter, 1 og 2 timer efter styrketræning.
Målemetode; stabile isotoper

Træning; 10x10 knæekstentioner (3 min. mellem sæt, 70% af 1RM)

Konklusion

We conclude that EAA + CHO ingestion before resistance exercise does not enhance postexercise FSR compared with exercise without nutrients.

Coordinated collagen and muscle protein synthesis in human patella tendon and quadriceps muscle after exercise

J Physiol 567.3 (2005) pp 1021–1033

Benjamin F. Miller[1], Jens L. Olesen[1], Mette Hansen[1], Simon Dossing[1], Regina M. Crameri[1], Rasmus J. Welling[1], Henning Langberg[1], Allan Flyvbjerg[2], Michael Kjaer[1], John A. Babraj[3], Kenneth Smith[3,4] and Michael J. Rennie[3,4]

Design:

1 time knæ-ekstension (maskine med 67% af "workload-max).

Måling af proteinsyntese I forskellige muskelfraktioner

Måling af proteinsyntese med forskellige isotoper/AA.

Vigtigt er den relative forskel mellem de 3 forskellige proteinfraktioner

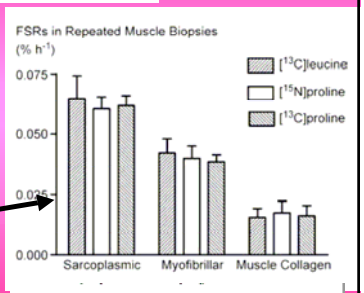
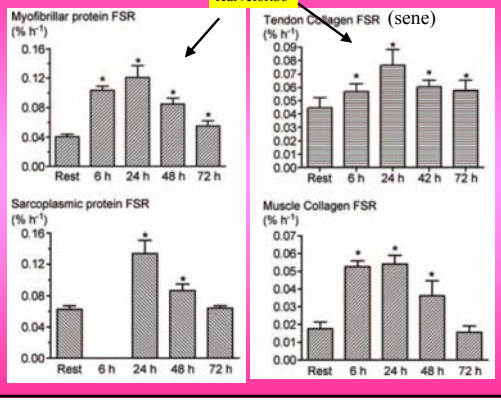


Figure 3. No difference ($P \geq 0.05$) between FSR of proteins in repeated rested muscle biopsies on three different days (top) or

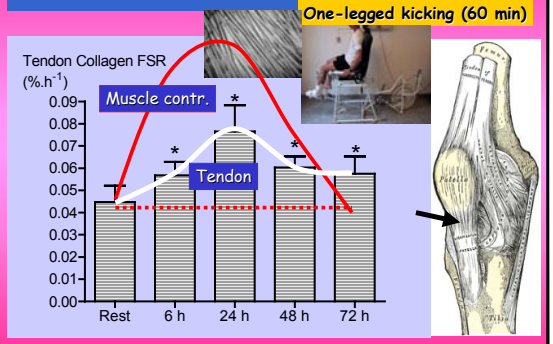
Proteinsyntese i proteinfraktioner over tid

Kurveforløb



Collagen synthesis in human tendon

One-legged kicking (60 min)



(Miller et al. J.Physiol. 2006)

Resistance training reduces the acute exercise-induced increase in muscle protein turnover

S. M. PHILLIPS, K. D. TIPTON, A. A. FERRANDO, AND R. R. WOLFE

Am. J. Physiol. 276 (*Endocrinol. Metab.* 39): E118–E124, 1999.

Design: 2 grupper; utrænede og trænede. Et styrketræningspas. Ekcentrisk 10 x 8 x 120% af 1 RM. Et-bens arbejde, andet ben =kontrol.

Protein-syntese

Protein-nedbrydning

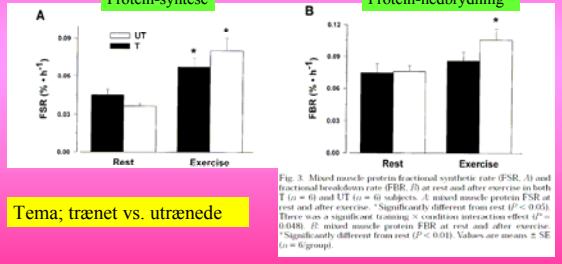


Fig. 3. Mixed muscle protein fractional synthetic rate (FSR; *A*) and fractional breakdown rate (FBR; *B*) at rest and after exercise in both T (n = 6) and UT (n = 6) subjects. *A*: mixed muscle protein FSR at rest and after exercise. *Significantly different from rest ($P < 0.05$). There was a significant training × condition interaction effect ($P = 0.048$). *B*: mixed muscle protein FBR at rest and after exercise. *Significantly different from rest ($P < 0.01$). Values are means ± SE (n = 6/group).

Tema; trænet vs. utrænede

Net syntese før og umiddelbart efter træning

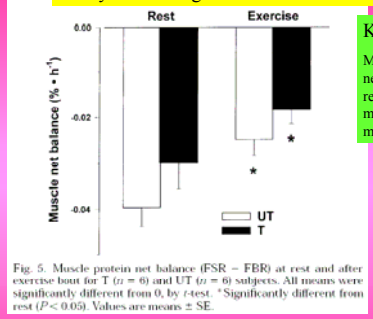


Fig. 5. Muscle protein net balance (FSR − FBR) at rest and after exercise bout for T (n = 6) and UT (n = 6) subjects. All means were significantly different from 0, by t-test. *Significantly different from rest ($P < 0.05$). Values are means ± SE.

Konklusion:

Mindre syntese og mindre nedbrydning ved sammen relative mængde arbejde i muskler fra trænede end i muskler fra utrænede.

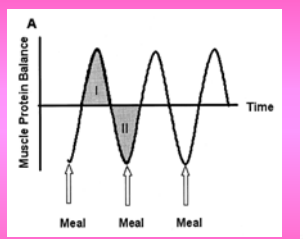
Tema; trænet vs. utrænede

Protein Requirements and Supplementation in Strength Sports

Stuart M. Phillips.

Nutrition 20:689–695, 2004

Hvordan ser alt det så ud med lidt kurver?



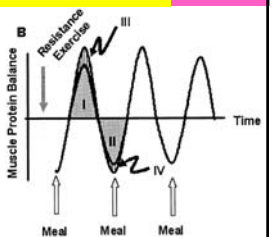


FIG. 3. (A) Normal fed-state gains and fasted-state losses in skeletal muscle protein balance (synthesis minus breakdown). The area under the curve in the fed state (I) would be equivalent to the fasted loss area under the curve (II); hence, skeletal muscle mass is maintained by feeding. (B) Fed-state gains and fasted-state losses in skeletal muscle protein balance with performance of resistance exercise. In this scenario, fasted-state gains are enhanced by an amount equivalent to the stimulation of protein synthesis brought about by exercise (III). In addition, fasted-state losses appear to be less (IV) due to persistent stimulation of protein synthesis in the fasted state.[10]

Betydning af specifik træningstilstand for proteinsyntesen

Differential effects of resistance and endurance exercise in the fed state on signalling molecule phosphorylation and protein synthesis in human muscle *J Physiol* 586.15 (2008) pp 3701–3717

Sarah B. Wilkinson[1], Stuart M. Phillips[1], Philip J. Atherton[2], Rekha Patel[2], Kevin E. Yarasheski[3], Mark A. Tarnopolsky[4] and Michael J. Rennie[2]

Design

- Protein syntese målt i utrænet ben før og efter både styrketræning og udholdenhedstræning. Derefter 10 ugers styrketræning med det ene ben og 10 ugers udholdenhedstræning med det andet ben.

- Afsluttende med måling af protein syntese før og efter styrketræning eller udholdenhedstræning i begge ben (ST for styrketr. ben og UT for udholdtr. ben.

- Måling af proteinsyntesen for både den myofibrilære og mithocondrielle fraktion

Protein Requirements and Supplementation in Strength Sports Stuart M. Phillips. Nutrition 20:689–695, 2004

Betydning for syntese og nedbrydning, af AA suppl.

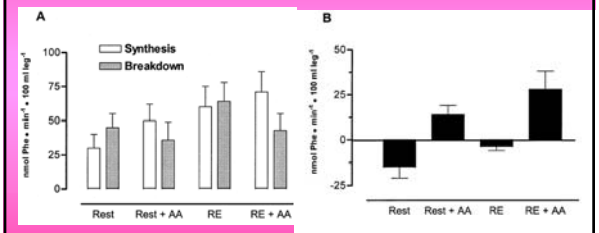


FIG. 2. (A) Influences of AA consumption at rest, performance of RE, and AA consumption after RE on muscle protein synthesis and breakdown. (B) Net protein balance (synthesis minus breakdown) under the same conditions. Data are redrawn from Biolo et al.[3,29] Values are means ± standard deviation. AA, amino acid; RE, resistance exercise.

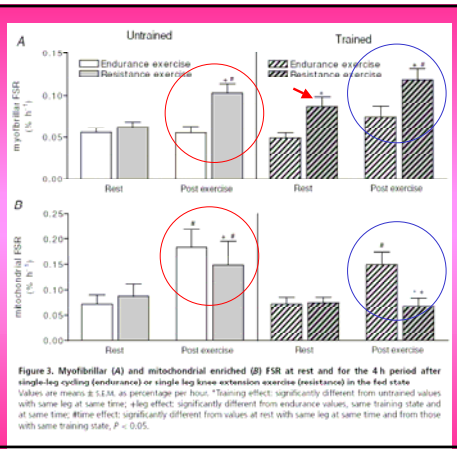


Figure 3. Myofibrillar (A) and mitochondrial enriched (B) FSR at rest and for the 4 h period after single-leg cycling (endurance) or single leg knee extension exercise (resistance) in the fed state
Values are means ± S.E.M. as percentage per hour. *Training effect: significantly different from untrained values with same leg at same time; ♦leg effect: significantly different from endurance values, same training state and at same time; #time effect: significantly different from values at rest with same leg at same time and from those with same training state, $P < 0.05$.

Konklusion:

Længerevarende træning af en bestemt type bevirker at musklen "gearer" protein syntesen i retning af de "behov" den pågældende type af træning stiller…"

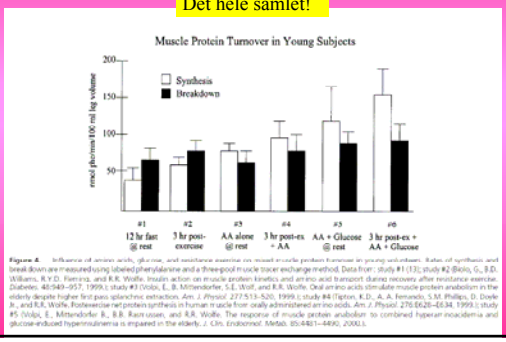
Pt. ingen sikre svar i retning af hvilke signaleringsstoffer der er forskellige i de to situationer.

These findings provide evidence that the human skeletal muscle protein synthetic response to different modes of exercise is, as hypothesized, specific for proteins needed for structural and metabolic adaptations to the particular exercise stimulus, and that this specificity of response is altered with training to be more specific.

Contractile and Nutritional Regulation of Human Muscle Growth *Exerc. Sport Sci. Rev.*, Vol. 31, No. 3, pp. 127–131, 2003.

Blake B. Rasmussen[1] and Stuart M. Phillips[2]

Det hele samlet!

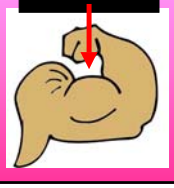


Opsummering

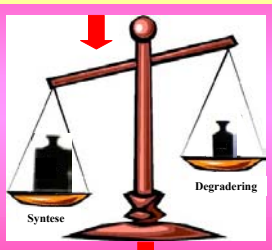
Hvis muskler skal vokse

Styrke træning

Signal…



Basalt set behøves mere protein. Derfor må ligevægten mellem protein syntese og protein nedbrydning



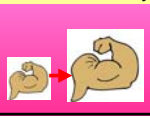
Protein syntesen skal være større end protein nedbrydningen

Hvad sker der under træning og umiddelbart efter?

Det er sandsynligt at der er en negativ net protein balance under træning. (Kumar et al., 2009)

Men..

De forandringer der sker I protein syntese og protein nedbrydning under arbejde er relativt små og sker inden for en begrænset, kort periode og er derfor af mindre betydning. (Kumar et al., 2009)



Hvad sker der i timerne og dagene efter træning?.

I den helt initielle post-trænings periode øges protein syntesen, men det gør protein nedbrydningen (Dreyer et al, 2006, Fujita et al, 2009, Kumar et al, 2009, Phillips et al, 1997).

Efter hård styrketræning vil protein syntesen være øget i omtrentlig 48 timer (måske helt op til 72 timer), hvorimod protein nedbrydningen er tilbage til basal niveau efter ca. 24 timer. (Kumar et al., 2009, Miller et al, 2005, Phillips et al, 1997).