Muscle volume is a critical determinant of rowing performance in Olympic rowers

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METHODS: 23 C57BL/6 (WT) and 24 Transgenic (A1) mice were used for this study, with A1 mice overexpressing the protein *PGC-1α.* Mice were injected with either PBS or Bupivacaine (MAR) at 12 weeks of age. Tibialis anterior (TA) muscle and tibias were excised 3-days post injection. Tissue was immediately frozen for gene expression analysis using RT-qPCR.
RESULTS: There was no difference between TAmass/Tibia length ratio in any mice 3-days post injection. *PGC-1α* gene expression was 13-fold greater in the A1-PBS group compared to the WT-PBS group ($p<0.05$). The A1-MAR group however, expressed approximately 4-fold less *PGC-1a* compared to the A1-PBS group 3-days post injection ($p<0.05$). In WT mice, *MyoD* gene expression was 1.5 fold greater in the MAR group compared to the PBS group ($p<0.05$), with no difference between A1 mice. There was a main effect of MAR to increase *Myogenin* gene expression in both WT and A1 mice. There was a main effect of genotype to decrease *LDH-A* expression ~50% in both A1 groups ($p<0.05$). There was a 4-fold increase in *LDH-B* expression in the A1-PBS group compared to the WT-PBS group ($p<0.05$). In WT mice, there was no effect of MAR on *LDH-B* gene expression. However, in A1 mice there was a 50% decrease in the A1-MAR group compared to the A1-PBS group ($p<0.05$). *TNF-α* increased approximately 2-fold as a main effect of genotype in both A1 groups ($p<0.05$).
CONCLUSION: A surplus of mitochondria may result in more ROS production and higher levels of *TNF-α*, resulting in altered expression of *MyoD*. With *TNF-α* possibly activating *NF-κB*, a nuclear factor shown to negatively regulate myogenesis. The differential response in *LDH-B* expression suggests *PGC-1α* is involved in altering glycolytic energy metabolism at the onset of muscle regeneration.

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Reliability and Comparison of Measurements of the Tibialis Posterior Cross-Sectional Area Via Ultrasound Imaging

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(No relationships reported)

PURPOSE: The tibialis posterior is a key muscle in controlling the medial longitudinal arch. Being able to assess the strength, activity and size of the muscle is crucial in understanding its role in controlling the functions of the foot. Difficulties exist in directly imaging this muscle due to the depth of its origin within the leg. This study's purpose was to evaluate techniques used to image the TP muscle size using ultrasound.
METHODS: 10 legs of 5 healthy college students were imaged via ultrasound (12ML probe, GE Logiq P6) and the cross-sectional area and thickness of the TP was recorded. To measure the TP the probe was held at the 30% and then the 50% point from the knee joint line to the inferior tip of the lateral malleolus. Subjects inverted their foot and videos of the contraction cycle were recorded. 2 separate still-shots of the muscle at rest were saved from the recorded videos to make size measurements. This process was performed on both anterior and posterior sides of the leg. To assess reliability intraclass correlation coefficients (ICC) were calculated. A correlation was performed to compare anterior to posterior measurements.
RESULTS: Excellent reliability was seen when comparing repeated measurements for anterior and posterior area and thickness measurements at the 30% point (ICC>0.96). There was a strong significant correlation between anterior and posterior measurements at the 30% mark ($r=0.91$, $p<0.001$). There was a non-significant weak correlation between anterior and posterior measurements at the 50% ($r=0.31$, $p=0.19$). The means and standard deviations of the cross-sectional area from the posterior view TP were 4.35 ± 0.49 cm^2 (30%) and 3.78 ± 0.47 cm^2 (50%). While the anterior view cross-sectional areas' were 4.18 ± 0.49 cm^2 (30%) and 3.42 ± 0.46 cm^2 (50%).
CONCLUSION: Repeated measurements showed excellent reliability. At the 30% point, the anterior and posterior measurements were highly correlated, thus either position could be used to image the TP. The anterior view, at the 50% should generally not be used because portions of the TP were often hidden behind bone which decreased accuracy of the measurement.

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Thigh Muscle Architecture Changes During a Soccer Season in Previously Injured and Non-injured Female Athletes

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Very little research has investigated muscle morphological and architectural characteristic changes on the individual thigh muscles during a competitive season in previously injured and non-injured collegiate athletes. Such research may provide important insight into sport-induced anatomical changes, which could have a significant impact on muscle performance and injury risks.
PURPOSE: To examine the influence of competitive women's college soccer participation on thigh and hamstring muscles' morphological and architectural characteristics.
METHODS: Eighteen soccer players (Previously injured n=8, age=20.43±0.90 yrs; Non-injured n=10: age= 20.31±1.38 yrs) volunteered to participate in the study. Participants reported a total of 4 times separated by 4 weeks during the season and underwent ultrasound testing to assess changes in muscle thickness (MT; cm), subcutaneous tissue thickness (ST; cm), pennation angle (PA; °), and echo intensity (EI) of the rectus femoris (RF), vastus medialis (VM), vastus medialis oblique (VMO), vastus lateralis (VL), vastus intermedius (VI), and biceps femoris (BF) muscles and thigh circumference measures using a tape measure. A 3-way (dominant side of the leg x injury history x time) ANOVA with repeated measure was used to analyze each variable. When interactions were present, Tukey-Kramer multiple comparison post-hoc tests were used.
RESULTS: MT of the RF, VI, VM, and VMO muscles increased between 4.4 and 14.5% at week 4 and 8 during the season ($P<.02$) regardless of the dominant side of the leg or injury history. EI of RF, VL, and VM muscles decreased between 3.1 and 8.1% at week 4 and 8 during the season ($P<.01$).
CONCLUSION: These results indicated that, muscle size and quality had improved in non-injured athletes but had diminished in those who were previously injured. Because no time-related differences in thigh circumference measures were observed it is possible that these measures may not be sensitive enough for detecting morphological changes. Given the relationship between muscle size and quality, it is possible that these unique morphological and architectural adaptations over time may influence athletic performance and/or potential risks of musculoskeletal injuries; however, future studies are needed to test these hypotheses.
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Muscle Volume Is A Critical Determinant Of Rowing Performance In Olympic Rowers

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BACKGROUND: Rowing races challenge rowers to combine high sprint and endurance capacity. Muscle morphology is an important determinant of sprint and endurance capacities and as such may also be a critical determinant of rowing performance.
PURPOSE: To determine how much of the rowing performance of Olympic rowers is explained by sprint and endurance capacity and by muscle morphology.
METHODS: 18 elite rowers (12 male, 6 female and 17 competed in different disciplines at the 2016 Olympics) performed a maximal incremental rowing test to obtain $\dot{V}O_{2max}$, reflecting the endurance capacity. Sprint capacity was assessed by a 30-second Wingate cycling test and maximal isometric knee extension torque. Morphology of m. vastus

lateralis (volume, physiological cross-sectional area (PCSA), fascicle length and pennation angle) was derived from a 3D ultrasound reconstructed voxel array. 13 rowers completed a 2000m time trial on a rowing ergometer to assess rowing performance. Coefficients of determination were obtained from multiple and single regression analyses.
RESULTS: Rowing performance was largely explained by absolute maximal oxygen uptake combined with peak power output obtained during the Wingate test (R^2=0.98, p<0.001). Muscle volume largely explained rowing performance (r^2=0.85, p<0.001) and was strongly related to Wingate peak power output (r^2=0.82, p<0.001), $\dot{V}O_{2max}$ (r^2=0.65, p<0.0001) and maximal isometric knee extension torque (r^2=0.60, p<0.001). Less variance in rowing performance was explained by PCSA (r^2=0.68, p<0.001) and fascicle length (r^2=0.43, p<0.05) and none by pennation angle (r^2=0.00, p=0.774).
CONCLUSION: Rowing performance of Olympic rowers is excellently explained by $\dot{V}O_{2max}$ and Wingate peak power output (R^2=0.98). Muscle volume, of all morphological properties, is the most important determinant of rowing ergometer performance, and endurance and sprint capacity in Olympic rowers.
Funding: Technologiestichting STW

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Effects Of Time-of-day Specific Resistance Training On Muscle Strength And Muscular Il-6-associated Signaling In Male Rats

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PURPOSE: Muscle mass and strength play an important role in athletic sports and health promotion. Although resistance training (RT) is known to be effective for muscle mass improvement, the optimal daily timing of RT and feeding has not yet been determined. The purposes of the present study are to investigate the best daily timing of RT for the muscle hypertrophy in male rats.
METHODS: In study I, SD rats were divided into Control (C, non-exercise), Early (E, beginning of active phase, 8:00) and Late (L, end of active phase, 17:00). Rats of exercise groups (E and L) were asked to perform RT by climbing for 10 weeks in beginning and end of active phase respectively. Climbing strength and weight of flexor hallucis longus (FHL) and flexor digitorum profundus (FDP) was determined after 10 weeks training. In study II, rats were divided into E (Early) and L (Late) groups and were performed an acute RT by climbing. FDP muscle samples were obtained 2, 6 and 24 hours after RT.
RESULTS: In study I, we observed that 10 weeks RT improve muscle strength, muscle mass and myofiber cross sectional area (CSA), but these training effects do not show any significant difference between E and L groups. In study II, acute RT in the evening induced more plasma testosterone/cortisol and IL-6, and muscular IL-6 associated signaling such as phosphorylation of STAT1 and STAT3 compared to training in the morning.
CONCLUSIONS: we suggest that resistance exercise-induced IL-6 signal in skeletal muscle is not the main source of 10 weeks resistace training adaptation.

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Characterization of Protein Metabolism in Undifferentiated and Differentiated Murine Muscle Tissue

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(No relationships reported)

The emergence of cell culture experiments have greatly expanded the understanding of skeletal muscle physiology. However, there is a paucity of data regarding the behaviors of cells grown in culture at various stages versus in vivo. This preliminary set of studies was designed to assess alterations of anabolic responses between undifferentiated and differentiated muscle tissue.
PURPOSE: Determine if there is a disparity in fractional synthesis rates (FSR) between C2C12 myoblasts and myotubes. * 100
METHODS: C2C12 cells were plated at 200,000 cells per T25 flask and 600,000 cells per T75 flask with 5 mL and 12 mL DMEM (respectively) supplemented with 20% Fetal Bovine Serum and 1% gentamycin. Cells were cultured in an environment at held at a constant 37°C and 5% CO_2. Once cells reached confluence, media was changed to DMEM supplemented with 2% horse serum 1% gentamycin, 5% HEPES, 0.75% transferrin, and 0.75% insulin. Myoblasts were plated after the 4th passage. Deuterium oxide was applied 24 hours prior to harvest of the cells at a level of 4%. Media containing deuterium oxide was reserved for analysis. Cells were washed with multiple applications of PBS. Norris buffer was then applied to the flasks at 100 uL for T-25's and 300 uL for T-75's. Flasks were then placed on ice for 5 minutes. Cells were harvested and deposited into centrifuge vials. Vials were spun at 14,000 G for 30 minutes to separate cytosolic and myofibrallar fractions. The supernatant (containing the cytosolic fraction) from the vial was decanted into another vial and saved for analysis. 2H-alanine and plasma enrichment was determined by GC-MS and FSR was calculated by:
RESULTS: Preliminary data demonstrates that differentiated murine myotubes have ~76% FSR of the undifferentiated murine myoblasts (P < 0.005).
CONCLUSION: Future investigators must be aware of the ratio of undifferentiated cells and differentiated myotubes as this ratio could confound results as myoblasts are still present even at later stages of differentiation.

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Partial or Complete Unloading of Skeletal Muscle Leads to Specific Alterations of Anabolic Signal Transduction

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(No relationships reported)

Consequences of disuse atrophy of skeletal muscle observed during spaceflight on astronaut health and performance are a focal point of space research. Decrements of both muscle mass and protein synthesis rates have been observed with exposure to varying muscle loading environments (1G > partial loading > 0G), and most of the reduced muscle mass can be attributed to diminished rates of synthesis. However, specific mechanisms behind unloading-dependent reductions of protein synthesis are not well defined.
PURPOSE: To determine whether or not alterations of anabolic signal transduction was responsible for the changes previously observed in fractional synthesis rates with specific gravitational loading paradigms.
METHODS: Female BALB/cByJ were normalized by bodyweight and assigned to normal cage ambulation (1G), partial weight bearing suspension titrated to approximately 33% bodyweight (G/3), partial weight bearing titrated to 16% bodyweight (G/6) and full unloading of hind limbs (0G) in specially designed cages. All mice were subjected to that loading environment for 21d prior to tissue harvest, and monitored daily. Immunoblotting of the gastrocnemius (n=23) was carried out to analyze alterations of anabolic signal transduction. Although numerous signaling intermediates were assessed, the focus of this abstract will be on ribosomal protein S6 kinase (p70-S6K). This important protein has served as a marker of protein synthesis signal transduction as well as the anabolic capacity in skeletal muscle.
RESULTS: Regardless of loading paradigm, no differences were detected among groups for the activation of p70-S6K (as indicated by the phospho: total protein content). Total protein content, however, was ~27% lower than control in 0G and G/6 (P=0.008) with G/3 not being different from control (P>0.05).
CONCLUSION: In combination with previous data (unpublished observations), ambulation at G/3 is sufficient to maintain anabolic signaling capacity when compared to G/6 or 0G, suggesting that a threshold level of stimulus is necessary to maintain anabolic capacity in muscle. These results may have important implications towards the development of strategies designed to counter the effects of partial/complete unloading on skeletal muscle based on how the anabolic capacity of muscle is affected.