MONTHLY

THE S&C RESEARCH REVIEW

By Chris Beardsley

June 2019 Edition

Editorial by Chris Beardsley

Welcome to the June 2019 edition! This month covers several studies that assess the effects of detraining and retraining and the mechanisms that underlie those effects. Detraining after a period of training involves a reduction in both muscular strength and size. However, the losses in muscle size occur more quickly than the losses in strength. This seems to occur because the neural adaptations that contribute to strength gains are lost quite slowly. Furthermore, when retraining after a period of detraining, we tend to gain muscle at a faster rate than during the original training period. This has widely been attributed to the myonuclear domain hypothesis.

The myonuclear domain hypothesis supposes that a nucleus can (and usually does) only support a certain volume of cytoplasm within each muscle fiber. This naturally leads to an upper boundary being created for muscle fiber size unless extra nuclei are added from satellite cells. Thus, it predicts that myonuclei are added during strength training that leads to muscle fiber growth and lost during periods of detraining when muscle fibers experience atrophy. However, some studies have shown that myonuclei are not lost during detraining. It has therefore been suggested that the retention of these myonuclei during detraining might sustain faster muscle growth during retraining. New studies covered in this edition suggest that this probably isn’t the main underlying mechanism, however! Read on to learn more.

As always, there are a range of other studies covered, including investigations into plyometrics, sprinting, eccentric training, blood flow restriction (BFR) training, overreaching, and the biomechanics of different hip extension exercise variations. Whether you are interested in strength training for athletic performance, for strength sports, or for bodybuilding, there are plenty of new findings to read about.

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Gluteus maximus and adductor magnus roles in hip extension exercises

The gluteus maximus contributes to hip extension, along with the hamstrings and adductor magnus muscles. However, the contribution of each of these muscles is not the same at all joint angles. For example, the gluteus maximus contributes relatively more to hip extension movements when the hip is closer to full extension, while the adductor magnus contributes more when the hip is more flexed. Also, the hamstrings are generally greater contributors to hip extension when the knee is extended, compared to when the knee is flexed.

Key findings

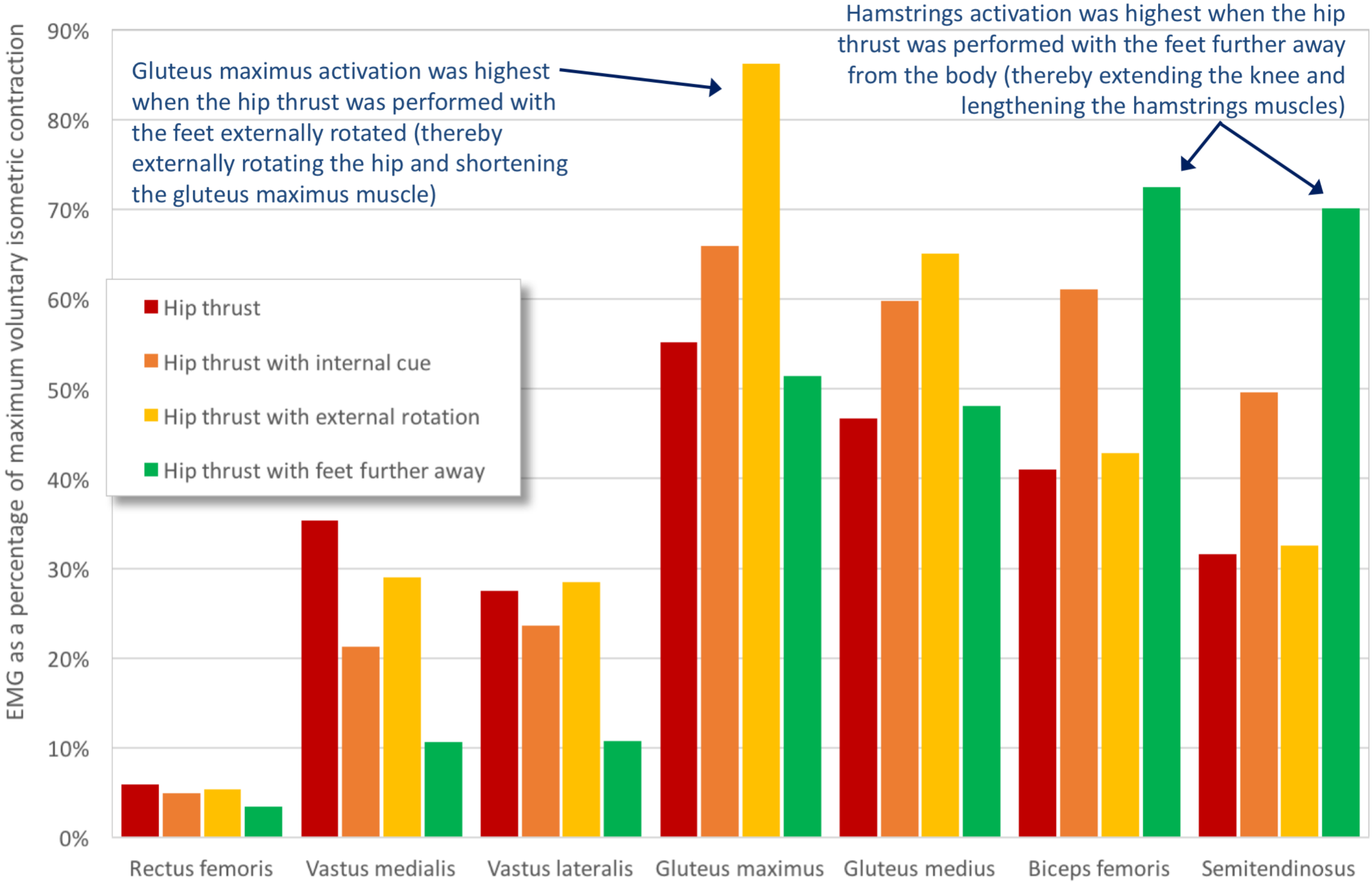
Prone hip extension with a straight leg at 45º of hip flexion involves similar levels of adductor magnus, gluteus maximus, and medial and lateral hamstrings activation. When the same exercise is done with the hip adducted, adductor magnus activation is increased, while activation of the gluteus maximus is decreased. When the same exercise is done with the hip abducted, gluteus maximus activation is increased.

Practical implications

Adducting the hip during hip extension exercises is likely to decrease the contribution of the gluteus maximus, while abducting the hip is likely to increase its contribution. Increasing the contribution of the gluteus maximus seems to reduce contribution of the other hip extensors (the adductor magnus and hamstrings). Decreasing the contribution of the gluteus maximus may only increase the involvement of the adductor magnus.

Comparison of hip extensor muscle activity including the adductor magnus during three prone hip extension exercises. Ko, H. I., Jeon, S. Y., Kim, S. H., & Park, K. N. (2019). *Physiotherapy Theory and Practice*, 35(5), 451-457.

Foot position affects gluteus maximus and hamstrings activation during the barbell hip thrust exercise



🔎 Strength-trained males did 8 reps of each hip thrust variation with 40% of hip thrust 1RM. The internal cue was "try to get your heels close to the glutes during the entire range of motion." The hip thrust with external rotation involved a wider foot stance and external foot rotation. In the hip thrust with feet further away, the distance of the feet from the bench was increased by the length of the foot. EMG was normalized to the MVIC for each muscle.

SUMMARY

For most of the tested hip thrust exercise variations, the gluteus maximus was more strongly activated than the other muscles. This supports the use of the hip thrust to target the glutes. Using a wider stance and externally rotating the feet (and therefore externally rotating the hip) increases the proportional involvement of the gluteus maximus, while moving the feet further away from the body increases the proportional involvement of the medial and lateral hamstrings.

Taken from: Collazo, C. G., Rueda, J., Suárez, B. L., & Navarro, E. (2018). Differences in the Electromyographic Activity of Lower-Body Muscles in Hip Thrust Variations. *The Journal of Strength & Conditioning Research*.

OBJECTIVE

To compare the proportional involvement of each of the hip extensors (adductor magnus, gluteus maximus, lateral hamstrings and medial hamstrings) during straight-leg hip extension exercise variations.

INTERVENTION

Subjects did three different dynamic, bodyweight hip extension exercises in a prone position. The upper body rested on a table with both hips at the edge of the table, the lumbopelvic region secured to the table with a belt, and the feet on the floor. Hip flexion was set at an angle of 45° and the knee was fully extended. For each exercise, the leg was raised to a target bar corresponding to 10° of hip extension. Subjects did this exercise with the hip (1) in a neutral position in the frontal plane, (2) at 10° of hip adduction, and (3) at 30° of hip abduction.

POPULATION

22 untrained subjects (11 females and 11 males), aged 19 – 26 years

MEASUREMENTS

Muscle activation: By recording electromyography (EMG) amplitudes of the adductor magnus, gluteus maximus, lateral hamstrings and medial hamstrings muscles using surface electrodes, normalized to the levels achieved during maximal voluntary isometric contractions (MVIC) during manual muscle testing in conventional positions.

RESULTS

Hip extension

There were no significant differences between muscles during hip extension with the hip in a neutral position in the frontal plane.

Hip extension with adduction

There were significant differences between the muscles for the EMG amplitude during hip extension in hip adduction. Specifically, the adductor magnus was more strongly activated than the gluteus maximus (86% vs. 42%), but adductor magnus and gluteus maximus activation levels were not significantly different from medial and lateral hamstrings activation (61% and 61%).

Hip extension with abduction

There were significant differences between the muscles for the EMG amplitude during hip extension in hip abduction. Specifically, the gluteus maximus (88%) was more strongly activated than the adductor magnus (44%), medial hamstrings (45%) and lateral hamstrings (38%). Activation levels of the adductor magnus, medial hamstrings, and lateral hamstrings were similar to one another.

SUMMARY

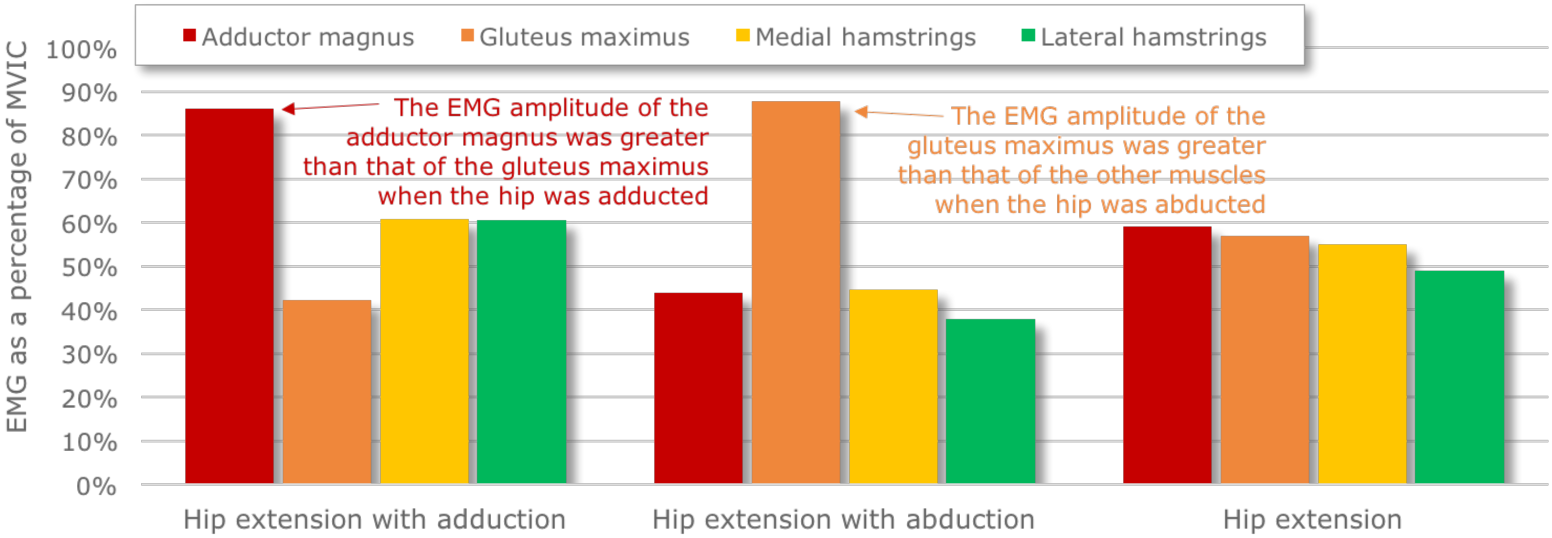
Prone hip extension with a straight leg at 45° of hip flexion involves similar levels of adductor magnus, gluteus maximus, and medial and lateral hamstrings activation. When the same exercise is done with the hip adducted, adductor magnus activation is increased, while the activation of the gluteus maximus is decreased. When the same exercise is done with the hip abducted, gluteus maximus activation is increased.

This study reported that prone hip extension with a straight leg at 45° of hip flexion involves similar levels of adductor magnus, gluteus maximus, and hamstrings activation. When the same exercise is done with the hip adducted, adductor magnus activation is increased, while the activation of the gluteus maximus is decreased. When the same exercise is done with the hip abducted, gluteus maximus activation is increased, and the activation of the other muscles seems to be decreased.

Hip extension is a key joint action for many sporting movements, including jumping, running, and side-step cutting (1). It is also key to many lower body strength training exercises, including the squat, deadlift, and lunge (1). Understanding how the various hip muscle groups contribute to hip extension is therefore very important.

There are three main hip extensor groups (the adductor magnus, gluteus maximus, and hamstrings). Each of these muscles contributes to the hip extension to a differing extent, depending on the combination of joint angles at the hip and knee. For example, the gluteus maximus contributes more to hip extension whenever the hip is closer to full hip extension, and less whenever the hip is in greater degrees of hip flexion (2,3). This seems to occur due to the changing internal moment arm lengths (MALs) of the muscle with joint angle. The gluteus maximus has a long MAL when the hip is fully extended, but a short MAL when the hip is flexed (4). Longer MALs allow a muscle to exert larger joint torques for the same muscle force, and are therefore assumed to be activated more readily than other muscles that contribute smaller joint torques for greater muscle forces (5).

Electromyography (EMG) amplitudes as a percentage of maximum voluntary isometric contraction (MVIC) during three different straight-leg hip extension exercises, in untrained male and female subjects



Similarly, the hamstrings contribute more to the hip extension movement when the knee is fully extended, and less when the knee is flexed (6,7,8). This may be because the hamstrings experience active insufficiency when the knee is flexed and the hip is being extended, and therefore cannot exert as much force.

One interesting observation is that the gluteus maximus increases its activation whenever joint actions are performed at shorter muscle lengths. For example, when hip extension is done in greater degrees of hip abduction (the gluteus maximus is a secondary hip abductor) or hip external rotation (the gluteus maximus is a primary hip external rotator), relative to a hip position that is neutral in the frontal and transverse planes, the activation of the gluteus maximus during hip extension exercises is increased substantially (8,9,10). Also, when hip extension is done in greater degrees of hip extension (2,3) or when posterior pelvic tilt is used (thereby increasing the amount of hip extension) (11,12), gluteus maximus activation during hip extension exercises is increased. Exactly why this phenomenon occurs is still unknown. It could be the result of geometry-related errors (surface electrodes might record a smaller EMG signal at longer muscle lengths due to the smaller surface area of muscle underneath the electrodes).

Alternatively, the phenomenon could occur because of either [A] longer gluteus maximus internal moment arm lengths as the hip approaches full hip extension (4), and [B] greater ability of the gluteus maximus to exert force when its muscle fibers run parallel to the direction of pull of the whole muscle, as is the case when the hip is either abducted or externally rotated (10).

Either way, this current study is consistent with these earlier findings, because gluteus maximus activation was increased when the hip extension exercise was done in hip abduction (which shortens the fibers of the gluteus maximus) and was decreased when the hip extension exercise was done in hip adduction (which lengthens the fibers of the gluteus maximus). It is logical that there was a change in the activation of the other hip extensors (relative to the hip extension exercise with the hip in neutral in the frontal plane) at the same time as a change in the activation of the gluteus maximus, because the external resistance was the same in both cases. Thus, altering the contribution of the gluteus maximus must also alter the contribution of the other muscles. It is also feasible that the adductor magnus behaves similarly and increases its contribution when it is shortened, as it was the only muscle to increase its activation during hip extension in hip adduction, as the activation of the gluteus maximus was reduced.

Conclusions

Prone hip extension with a straight leg at 45° of hip flexion involves similar levels of adductor magnus, gluteus maximus, and medial and lateral hamstrings activation. When the same exercise is done with the hip adducted, adductor magnus activation is increased, while activation of the gluteus maximus is decreased. When the same exercise is done with the hip abducted, gluteus maximus activation is increased.

Practical implications

Adducting the hip during hip extension exercises is likely to decrease the contribution of the gluteus maximus, while abducting the hip is likely to increase its contribution. Increasing the contribution of the gluteus maximus seems to reduce contribution of the other hip extensors (the adductor magnus and hamstrings). Decreasing the contribution of the gluteus maximus may only increase the involvement of the adductor magnus.

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