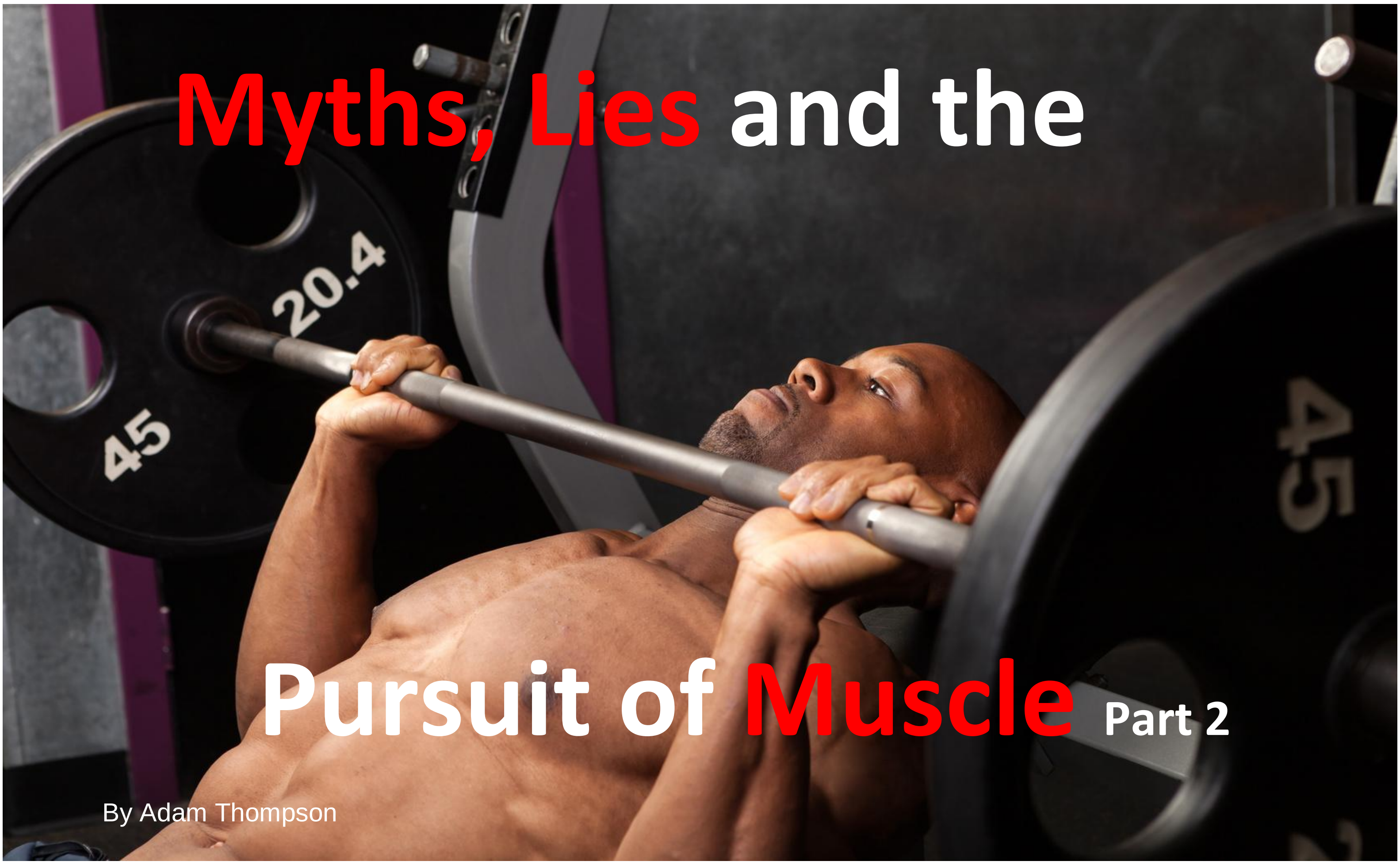

Myths, Lies and the Pursuit of Muscle Part 2

By Adam Thompson

Introduction

In part 1 of this 2 part special report we looked at the evidence supporting some common training strategies. Training to failure, forced repetitions and combining single- and multi-joint exercises are techniques regularly used in weight training programs. Despite their popularity and endorsement by the media the evidence on each does not show any significant benefit for long-term training adaptations.

In part 2 of this special report we turn our attention to three more common training techniques: pre-exhaustion, maximising muscle fatigue and repetition ranges.

Pre-Exhaustion

The premise behind pre-exhaustion is that a single-joint exercise is performed then immediately followed by a multi-joint exercise. This is believed to provide an enhanced stimulus because the first exercise fatigues the muscle while the second exercise utilises ancillary muscles to push the targeted muscles beyond their normal capacity. The end result, in theory, is a superior adaptation response.

Fisher et al[19] put 39 experienced male and female volunteers through a twice per week training program for 12 weeks. Exercises performed were chest press, leg press, lat pull-down, pec fly, leg extension,

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pull-over, lumbar extension and abdominal flexion. One group performed the exercises in pre-exhaustion style (pec fly/chest press, leg extension/leg press, pull-over/lat pull-down, abdominal flexion/lumbar extension), another performed the same exercise order but with a 2 minute rest between each exercise and a third group performed the multi-joint exercise first then the single-joint exercise with a 60 second rest in between. At the conclusion of the study all groups had increased their strength equivalently. No additional benefit was observed by performing the exercises in pre-exhaustion style.

Brennecke et al.[20] compared muscle fibre recruitment in the pectorals, anterior deltoid and triceps during a 10 repetition maximum bench press with and without pre-exhaustion (using a dumbbell fly). It was found that pre-exhaustion had no effect on muscle fibre recruitment in the pectorals and anterior deltoid but did increase triceps activity by 18%. This suggests the bench press alone maximises muscle activity in the pectorals and anterior deltoids. Pre-exhausting the pectorals does not increase the number of muscle fibres recruited when performing a bench press. It was observed that pre-exhaustion did alter the pattern of movement of the bench press. This is likely due to fatigue induced by the initial exercise.

Augustsson et al.[21] reported that muscle activity in the rectus femoris and the vastus lateralis during a set of 10 repetition maximum leg presses was significantly reduced when the legs were pre-exhausted with a single set of leg extensions. This suggests that for larger muscles pre-exhaustion may actually reduce the effectiveness of multi-joint exercises.

It is often argued that the effectiveness of multi-joint exercises is limited by the smaller muscle groups. These so called 'weak links' are believed to be the limiting factor in exercise performance. As demonstrated by Brennecke et al.[20] pectoral muscle recruitment was not influenced by the triceps. Despite an 18% increase in triceps muscle activity with pre-exhaustion, pectoral muscle activity remained the same. This suggests the smaller triceps muscles are capable of working at a sufficient intensity during a bench press to maximally stimulate the pectoral muscles. The idea of the triceps being a weak link during a bench press therefore has to be questioned.

Pre-exhaustion is a training strategy that has a logical basis but is not supported by the existing evidence. The limited number of studies that have been conducted do not show any benefit from using this technique. For smaller muscle groups it does not increase muscle fibre recruitment and does not enhance strength gains. For larger muscle groups pre-exhaustion can decrease muscle fibre recruitment during multi-joint exercises, possibly compromising long-term training adaptations.

Fatigue is a necessary stimulus for a hypertrophic response

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Of all the training strategies discussed so far the one thing that binds them is the association between fatigue and the adaptation response. Training to failure, forced repetitions, isolation exercises and pre-exhaustion are all designed to push the working muscles as far as they can go. The premise of fatigue being a necessary stimulus is based on the idea that as fatigue increases the body responds by increasing the number of muscle fibres recruited during the exercise. The more fatigued a muscle is the more muscle fibres will be recruited and the greater the adaptation response will be. At least that's the theory.

Much of the evidence relating to fatigue and the adaptation response has already been covered in training to failure and forced repetitions. Each of these techniques produces increasing levels of fatigue in the working muscles yet the outcomes are no better than with lower levels of fatigue (not training to failure and not utilising forced repetitions). If fatigue was a significant factor for the adaptation response then the research testing these methods should have found positive correlations but this has not been the case.

Finn et al.[22] had 15 volunteers perform 8 sets of Bulgarian split squats with 75% 1RM. Muscle activity in the vastus lateralis was measured throughout the session. Increasing levels of fatigue did not result in the activation of additional muscle fibres. Even though muscle force output decreased during the session additional muscle fibres were not recruited to compensate.

Drinkwater et al. [15] put 22 athletes through a 6 week bench press program using either 4 sets of 6 reps, 3 sets of 8 reps or 12 sets of 3 reps. The 4 x 6 and 12 x 3 groups performed more forced repetitions compared to the 3 x 8 group while the 12 x 3 group performed a greater volume of work. At the conclusion of the study it was found all groups had increased their bench press strength and power equally. This suggests that once a certain level of fatigue is reached further working the muscles through either forced repetitions or additional exercise volume does not elicit a greater adaptation response.

Further evidence disproving the association between muscle fatigue and the adaptation response comes from research on cluster training.

Oliver et al.[23] put 22 males through a 12 week periodized training program. The volunteers trained 4 days per week using traditional bodybuilding exercises. Half the subjects performed the exercises with 4 sets of 10 repetitions with 2 minutes rest between sets (traditional). The other half performed 8 sets of 5 repetitions with 1 minutes rest between each set (cluster). Training intensity and volume were equivalent between the two groups. At the conclusion of the study increases in muscle mass were the same for both groups but the cluster training group had gained more strength and power in the bench press and squat.

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In this study both groups performed the same volume of work so it could be argued that muscle fatigue would be the same. Cluster training breaks sets into smaller units of work which leads to greater muscle power output during each set[24]. Given that fatigue leads to decreases in muscle power output[5,22] the greater muscle power output observed with cluster training indicates a reduced level of muscle fatigue with this training strategy. If fatigue was a significant factor for the adaptation response then the traditional training group should have had greater strength and hypertrophy adaptations. As this was not observed fatigue cannot be considered a significant factor for training adaptations. Other studies have reached a similar conclusion[25].

There is some evidence that fatigue may be a contributing factor for short-term increases in strength in untrained individuals. Rooney et al.[26] put 42 untrained volunteers through 6 weeks of biceps curls performed 3 times per week. Half performed their repetitions as a traditional set while the other half performed each set as single repetitions with 30 seconds rest between each repetition. Volume and intensity were equivalent between the two groups. At the conclusion of the study biceps strength in the traditional group had increased 56% but only 41% in the cluster training group. Another study by Folland et al.[25] using leg extensions and an identical training protocol also showed increased strength gains after 4 weeks with a high fatigue protocol (4 sets of 10 repetitions) compared to a low fatigue protocol (40 repetitions with 30 seconds rest between each repetition). After 9 weeks this advantage was gone and both training protocols had equivalent increase in strength.

The evidence shows fatigue is not a significant stimulus for long term training adaptations. The use of training protocols designed to maximise muscle fatigue are therefore unwarranted.

You need heavy weights to build muscle

A common strategy used by weight training athletes is to tailor the number of repetitions they perform during each set to a desired outcome. Training with 5 repetitions or less is typically used to build strength, 6-12 repetitions are used to develop hypertrophy and more than 12 repetitions are used to build endurance. The number of repetitions used reflects the intensity of each set (measured as a percentage of the 1RM).

Schoenfeld et al.[27] put 18 males through an 8 week training program. Half trained with 8-12 repetitions while the other half trained with 25-35 repetitions per set. At the conclusion of the training period both groups were found to have increased the size of their biceps, triceps and quadriceps equally. Strength increases however were significantly greater in the 8-12 repetition group. Their squat strength increased 19.6% (compared to 8.8% in the high repetition group) and bench press strength increased 6.5% (compared to 2%). Upper body muscle endurance (measured by 50% 1RM bench press to

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failure) increased significantly more in the high repetition group compared to the lower repetition group (16.6% vs. -1.2%).

Another study by Schoenfeld et al.[28] involved 17 males who performed either a bodybuilding program with high repetitions and 90 second rest periods between sets or a strength program with low repetitions and 3 minutes rest between sets. At the conclusion of the 8 week program the strength training group increased their 1-repetition maximum bench press and squat significantly more than the bodybuilding group however increases in muscle mass were similar between both groups.

Ahtiainen et al.[29] put 13 males through a 12 week training program utilising either moderate training loads and moderate repetitions with 2 minutes rest between sets or heavy training loads and low repetitions with 5 minutes rest between sets. The total volume of work performed was equivalent between each training protocol. It was found both styles of training increased strength and muscle mass to a similar degree.

The evidence suggests the functional adaptations (strength and endurance) resulting from a resistance exercise program occurs independently of the hypertrophic adaptations. In the studies discussed above different training protocols resulted in equivalent increases in hypertrophy but a higher intensity with lower repetitions produced more strength while the lower intensity and higher repetitions produced greater endurance.

A key point is that volume is approximately the same despite the different intensities and repetition ranges. This means hypertrophy adaptations may be determined largely by the volume of work performed while strength and endurance adaptations are determined by the training load and repetition range. An athlete training for maximum hypertrophy therefore does not need to limit themselves to a specific repetition range. Provided they perform sufficient volume of work the hypertrophic response should be optimised regardless of the intensity and repetitions used for each set.

Conclusion

For the average athlete their weight training knowledge comes from various media sources and other people in the gym. As well intentioned as all these sources are the information they part may not always be reliable. Despite the logic used to support training strategies such as training to failure, forced repetitions, single-joint exercises, pre-exhaustion, maximum muscle fatigue and training with specific repetition ranges, the scientific evidence simply does not justify their use.

In order to achieve your weight training goals you need to use training techniques and strategies that work and avoid those that do not. It may be difficult to accept that many of these common techniques offer little to no benefit but if you want to progress in your training you need to listen to the evidence.

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