

# Practical Occlusion Training

By: Jeremy P Loenneke, Southeast Missouri State University

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## Introduction

Restricting blood flow to a muscle, and exercising; doesn't that sound ridiculous? I used to think so, until I came across occlusion training. Occlusion training is a fairly new mode of exercise that allows one to train at very low intensities and receive the benefit of high intensity exercise. Intensities as low as 20% 1RM have been shown to result in increased muscle mass when performed with moderate blood flow restriction with no increase in markers for muscle damage (Loenneke & Pujol, in press).

How can this benefit bodybuilders? As we all know, it's hard to train at high intensities (>85% 1RM) day in and day out. Those conditions drain you both physically and mentally. Occlusion training allows you to give not only your joints a break from the heavy loading, but also your mind.

## Mechanisms

What does restricting blood flow do that translates into bigger muscles? There are a variety of proposed mechanisms, but a few seem to be the most prominent. The three mechanisms below appear to act together to produce an environment that is favorable to muscle growth with low intensity occlusion training.

1. Fiber Type Recruitment (Fast twitch fiber recruitment)
2. Accumulation of Metabolites (lactic acid → acidic environment → GH secretion)

### 3. mTOR pathway activation (protein synthesis)

## Fiber Type Recruitment

During low intensity exercise, slow twitch fibers (oxidative) are primarily recruited as they are able to adequately handle the workload. This isn't advantageous to bodybuilders because, fast twitch fibers (glycolytic) have the greatest potential for growth. When one moderately restricts blood-flow, it limits the amount of oxygen available to the slow twitch (oxidative) fibers thus causing a rapid recruitment of fast twitch (glycolytic) fibers to handle the workload. Thus with occlusion, fast twitch fibers are able to be trained with a low-intensity workload. EMG (electromyography) studies were completed to confirm that there is an increase in motor unit firing with occlusion. The EMG data also revealed no difference between low intensity occlusion training and high intensity exercise (Moritani, Michael-Sherman, Shibata, Matsumoto, & Shinohara, 1992; Takarada, Tsuruta, & Ishii, 2004). This means that despite the light weight, the firing rate mimics that of heavy resistance training.

## Metabolic Accumulation

Occlusion training with low intensities has shown increases in lactate and growth hormone (GH). The increase in GH has actually been shown to be even higher than that seen with heavy resistance training. One study in athletes showed a 290x increase in GH over baseline (Takarada, Nakamura, Aruga, Onda, Miyazaki, & Ishii, 2000). Lactate increasing is linked to GH, in that an increase in lactate makes the environment within the muscle more acidic. Remember, there is an inverse relationship between lactate and pH, so as lactate increases, pH decreases. There is evidence to indicate that a low pH stimulates the pathway that plays an important role in the secretion of GH (Gosselink, et al., 1998).

## mTOR Pathway

The mTOR pathway has also been shown to be activated with low intensity occlusion training (Fujita, et al., 2007). This pathway is responsible for protein synthesis.

Phosphorylation of S6k1 was increased by three-fold following occlusion training and

remained elevated at 3 hours post exercise. This increase in protein synthesis means the body is primed for muscle growth.

Fast twitch fiber recruitment, metabolic accumulation, and mTOR activation are three of the most prominent mechanisms involved in the muscle building effects seen with occlusion training. There are others that likely play some role, but the aforementioned are likely the most prominent. Other potential mechanisms include increases in Heat Shock proteins, NOS-1, and decreased expression of myostatin.

## **Occlusion Device**

So you know the benefits, you know the mechanisms, but how would a bodybuilder occlude a muscle? The research uses something called a KAATSU apparatus. This is an expensive machine that many of us don't have lying around. My lab has been working on a practical way to do this by testing the effects of elastic knee wraps. We have postulated that tying elastic knee wraps around the legs will induce a stimulus similar to that of using expensive equipment. Our latest study was to examine a protocol that could be utilized by the greatest number of people. Having blood flow restricted is very uncomfortable, so our lab has directed efforts to find ways to increase the comfort to pain ratio. We investigated the lactate response to low-intensity exercise with blood flow being restored after each set. Our preliminary data has shown that when flow is restored to normal it does not induce a significant rise in lactate over control. This tells me that when blood flow is restored after each set, it doesn't allow for the intensity of the exercise to change enough to see a rapid recruitment of additional fibers. So when prescribing occlusion training, it seems essential to keep the occlusion on throughout the exercise, to allow for the necessary intramuscular environmental changes to occur leading to muscular growth. Since it is only preliminary research, future efforts will/are being done to find out more.

Occlusion for the upper body can also occur by using elbow wraps for the upper arm and wrist wraps for the forearms. Again, you would wrap it proximal to the muscle you wish to train. If you are hitting biceps that day, elbow wrap the very top of your upper arm, and for forearms you would occlude the upper portion of your lower arm (elbow area). In the next section, I'll discuss how to receive occlusion benefits for the upper body.

## **Exercise Rx for UPPER/LOWER**

As I've stated before, our lab did not see a significant difference in lactate between groups, when blood flow was restored in between sets. Thus, I would recommend leaving the elastic knee wraps on throughout until the 4 sets have been completed. This stimulus will likely allow for the increased recruitment of Type 2 fibers, which would result in a significant increase in lactate. Occlusion benefits for the lower body have been very promising, in that every study has shown significant increases in muscle mass over the control.

As far as occlusion for the upper body, an interesting paper from Madarame et al. (2008) has shown that one can receive benefits of occlusion for the upper body by occluding the lower body. This cross-over effect is likely attributed to the large increase in hormones due to the larger muscles of the leg musculature. The larger quadriceps will increase hormones more so than the smaller biceps. Madarame showed that when occlusion of the legs followed a light upperbody exercise, it resulted in significant hypertrophy.

Although indirect occlusion for the upper body is effective, as stated previously, it is possible to also directly occlude the upper body by using elbow and wrist wraps. Obviously, this would directly effect the biceps, triceps, and forearms. So what about the other muscles of the upper body? There is research out of Fujita's laboratory in Japan that suggests that one can hypertrophy the chest, by occluding the upper portion of the arm. The idea is that during the bench press, the triceps would fatigue fast, resulting in a higher recruitment of the chest to pick up the load. One would also suspect that the same could be

done for the back, by occluding the arm in the same spot (very top of the arm).

Theoretically, during a lat pull down, occluding the biceps would cause a higher recruitment of fibers from the back.

One of the most interesting studies was conducted by Abe et al. (2006). They have found that walking at very low speeds on a treadmill results in bigger muscles too.

Muscular growth occurred at a speed of about 2 mph. Below is an exercise prescription for both the legs and upper body. I have also included a small section on cardio recommendations. To use the tables you will need to know how to figure percentages of your one repetition maximum.

**Minimum Intensity Equation= Your One Repetition Maximum X 0.2**

**Maximum Intensity Equation= Your one Repetition Maximum X 0.5**

For example, if you're 1RM on the BB Squat is 405 pounds, here's how you would figure your intensity.

$405 \times 0.2 = 81$  pounds would be the minimum weight you would work with.

$405 \times 0.5 = 202.5$  pounds would be the maximum weight you would work with.

**Table 1.** Lower body Recommendations

Lower Body Exercise	Sets/Reps	Rest	Intensity
BB Squat	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM
Leg Press	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM
Leg Extension	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM
Leg Curl	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM
Hack Squat	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM
Romanian Deadlifts	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM
Calve Raises	4/30-15-15-15	30 seconds-1 minute	20-50% 1RM

Upper body occlusion is basically performing an exercise for the body part you wish to grow at a low intensity (50% 1RM) followed by occluding the legs. Training at 50% 1RM is low enough intensity that you aren't causing a major stress to the joints, but it appears sufficient enough to activate the hormonal receptors (Madarame, Neya, Ochi, Nakazato, Sato, & Ishii, 2008). So let's say your max bench is 400 pounds, you would use 200 pounds with normal bloodflow for 3 sets of 10, followed by occlusion with the leg extension and leg curl. Occluding the large musculature of the legs will result in a huge increase in hormones. Hormones are transported in the blood and blood goes everywhere in the body. So, the hormone release from the lower body will be transported to the hormone receptors activated with the upper body exercise. Obviously you could do it for many different exercises, but listed below are just a few to give you an example.

**Table 2.** Upper body Recommendations

Upper Body Exercise	Sets/Reps	Rest	Intensity
BB Bench Press*	3/10	1 -2 minutes	50% 1RM
BB Military*	3/10	1 -2 minutes	50% 1RM
BB Curl*	3/10	1 -2 minutes	50% 1RM
BB Row*	3/10	1 -2 minutes	50% 1RM
Lat Pulldown*	3/10	1 -2 minutes	50% 1RM
DB Tricep Extensions*	3/10	1 -2 minutes	50% 1RM
Dips*	3/10	1 -2 minutes	50% 1RM

\*indicates that when you have finished the exercise, you wrap your legs and perform 3 sets of leg extension and/or 3 sets of leg curls. The intensity of the leg extension/leg curl is set at 3 sets of 30% 1RM on leg extension/leg curl. Reps are set at 30-15-15 with 30 seconds to 1 minute rest between each set. Here's an example of how it would look for the bench.

1. Bench Press your 3 sets at 50% 1RM

2. Wrap your legs for 3 sets of 30-15-15 at 30% 1RM on leg extension with 30 seconds-1 minute rest
3. Take the wraps off and wait for ~5 minutes to restore bloodflow
4. Wrap your legs again for 3 sets of 30-15-15 at 30% 1RM on leg curl with 30 seconds-1 minute rest.
5. Take off wraps

As stated earlier, there is evidence to indicate that walking at low speeds occluded, results in skeletal muscle hypertrophy. Abe et al. (2006) had subjects walk on a treadmill at ~2mph for 5 sets of 2 minute intervals with 1 minute rest between intervals. They did this twice a day and after 6 weeks the subjects who had been walking occluded gained a significant amount of muscle over those in the control who were walking with normal bloodflow. So how can you receive this benefit at your gym? If you want to train your upper leg, wrap the very top portion of your thigh. However, if you want to train calves, wrap the knee wraps around your knees, as you would for squatting. Instead of completely resting between intervals, I recommend lowering the intensity and just moving slower than you were for your actual working interval. For example, with the elliptical, let's say you are sticking with LEVEL 10 for your resistance during the intervals, lower it to LEVEL 4 or 5 for your rest interval. Remember, you shouldn't be in an all out sprint during the working interval, light to moderate seems to be the most effective environment for the benefits of occluded cardio.

## Conclusions

In conclusion, this paper has discussed the mechanisms by which occlusion works and even more important, how a bodybuilder can occlude a muscle to receive the benefits of training heavy with lighter weight. Outlined in this text are different exercise prescriptions for the lower body, upper body, and even cardio recommendations.

### **Some Key Points**

- I would recommend that one not occlude a muscle for more than 30 minutes at a time  
This is purely a safety concern. One must understand the difference between acute and chronic effects. Acute blood flow restriction is a definite positive, but chronically cutting off blood flow would likely result in actual tissue death.
- Never use occlusion with anything above 50% 1RM  
As bodybuilders, we often fall into the trap of more is better. If a person would use occlusion with heavy lifting; 1) they are defeating the point of occlusion training; 2) it doesn't appear to have a synergistic effect anyway (Laurentino, et al., 2008); and 3) I believe this could cause potential harm to the body.
- Wrap the knee wraps tight, but not crazy tight (We want moderate occlusion, not full occlusion)  
This goes back to the phrase, moderate blood-flow restriction, NOT COMPLETE. We only need a moderate change to receive benefit.
- If you have any indications of impaired endothelial function (Diabetics included), DO NOT OCCLUDE  
If a person already has an impaired vascular system, I would urge them not to try occlusion as it could be very dangerous to their well-being.

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#### ***Brief Author Biography***

Jeremy Loenneke is a Graduate Student at Southeast Missouri State University in the Nutrition, Exercise Science program where his main focus is Vascular Occlusion Training. He also is a competitive natural bodybuilder in the OCB. Jeremy can be reached at [jploenneke1s@semo.edu](mailto:jploenneke1s@semo.edu)

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