Breathing during weight training

The Roundtable is a regular feature of the NSCA Journal. Invited strength training and conditioning professionals and researchers respond to selected questions posed by the NSCA editorial staff. Since the Roundtable is unedited, their answers do not necessarily represent the views and opinions of the NSCA, but those of the author. Therefore, responses should not be used as reference resources unless the author has properly documented his statements. It is the responsibility of the reader to review each response and evaluate its merit.

1. Why is proper breathing important during weight training?

Landen: From a biomechanical standpoint, you must "inflati" or "pressurize" the thoracic cavity in order to provide the necessary support for the thoracic spine. According to Morris et al. (5), the ligamentous spine (i.e. vertebrae and ligaments) can only withstand four to five pounds of force before it will topple. Research has shown that the forces on the spine during squatting are in the range of 2,000 to 3,000 pounds (3). The other support mechanisms include the muscles surrounding the spine and the use of intra-cavity pressures such as intra-thoracic pressure (ITP) for the chest region and intra-abdominal pressure (IAP) for the lumbar region. ITP and IAP work in concert with each other, providing either a stable top or bottom to the cavity in question by aiding in the stability of the diaphragm muscle. Due to physiological considerations, these pressures cannot be maintained indefinitely, and therefore you must breathe.

Kreis: When proper breathing is used during training, it allows for a rhythm to be set up for the athlete to follow. The rhythm helps set the pace according to the amount of reps to be completed. Being able to control the breathing pattern will be beneficial in accomplishing the lift. This breathing pattern allows the athlete to fully concentrate mentally and physically in order to excel. The rhythmic breathing pattern is different in every individual and/or athlete.

Palmieri: Since the energy needed to perform most weight training exercises is primarily provided by the body's anaerobic energy systems (3), as far as energy utilization is concerned, breathing is not necessary during the execution of weight training exercise. However, breathing is necessary to maintain "normal" intrathoracic pressure, as well as an elevated venous return and cardiac output (3). Failure to breathe properly could diminish the blood supply to the brain, hence resulting in dizziness or fainting.

Roll: Proper breathing may be important during weight training for several reasons. Creating the tension reflex is important in high intensity lifting. Also, proper breathing should be used to insure stability while maintaining good technique. According to Vorobyer, the strength of a muscular contraction is greater when holding the breath... The phenomenon of tension is closely related to breathing... it positively influences the strength of the skeletal musculature (2). Accompanying the tension phenomenon is a characteristic increase of pressure in the abdominal and chest cavities. The mechanoreceptors of these cavities signal to higher parts of the nervous system about increases in pressures. The central nervous system in turn sends impulses increasing tone of the skeletal muscle and increasing the strength of the contraction. There are limitations placed by this increase of pressure as they affect the flow of blood in the body. This will be further discussed in Question 2.

However, increasing pressure/proper breathing may be used advantageously for stability purposes, thus insuring good technique. In the squat, for example, it is our philosophy that the musculature of the lower back is stronger for stability in a static contraction. By increasing pressure in the chest and abdominal cavity, not only does it make the static contraction of the lower back more powerful, but the pressure of trapped air in the lungs and high abdominal pressure increase support to the vertebral column. This possibly helps maintain correct technique, making the lift safer.
2. Describe the Valsalva maneuver and its effects. Is the Valsalva maneuver ever recommended during weight training?

Palmieri: The Valsalva maneuver is the forced exhalation of air from the lungs against a closed glottis. This procedure can drastically increase the intrathoracic pressure, limiting venous return, cardiac output, and blood flow to the brain. Additionally, erratic blood pressure may result (4). Dizziness or fainting may result from the Valsalva maneuver.

McArdle, Katch and Katch (3) write that during the Valsalva maneuver, the abdominal and chest cavities are stabilized, which in turn enhance the muscles' ability to lift heavy weight. Therefore, during maximal efforts in weight training, the Valsalva maneuver could improve one's performance. However, this technique should not be incorporated for more than a few seconds or the above mentioned effects may result.

Lander: The Valsalva maneuver is the method by which you can increase ITP. It involves taking a deep breath, closing the glottis, and then attempting to expire. Numerous studies have examined the physiological effects of the Valsalva maneuver. Four phases have been identified (1, 2).

1. Phase 1 (onset of straining) - there is an immediate rise in the arterial blood pressure (BP) and a sudden decrease in heart rate (HR). Due to the high pressure in the thoracic cavity, blood escapes from the lungs to the periphery.

2. Phase 2 (sustained straining, begins two to three seconds after onset) - blood becomes dammed back in the venous system, causing a slow and gradual rise in venous BP. This in turn causes a decrease in the arterial BP and increase in HR to compensate.

3. Phase 3 (immediate post strain) - BP drops in response to the sudden cessation of straining, causing a further increase in HR.

4. Phase 4 (bradycardia, decreased HR) - the blood again is able to enter the right heart to be pumped throughout the system and results in an overshoot in BP, which in turn causes reflex bradycardia.

I would recommend that the Valsalva maneuver be used during weight training, particularly when a stable trunk is needed. This definitely includes exercises such as squats, pulls, and cleans. Bench and incline presses also require a stable chest cavity as well as any lifting done while standing, such as curls, rows and the like, although the minor exercises require much less stability in many cases.

Austin: The Valsalva maneuver means making an expiratory effort with the glottis closed. The effects of performing the Valsalva maneuver:

1. increase intrathoracic pressure, which causes systolic and diastolic blood pressure to increase.

2. after a period of several seconds, during which blood in the lungs furnishes the venous return, the decreased venous return brings about a decreased pulse pressure.

3. after release of the straining activity, there is an increase in mean pressure and pulse pressure due to the improved venous return of blood, which had been blocked. Because of the possible harmful effects of the increased pressure upon the heart and
Roll: The Valsalva maneuver is the closing of the glottis (the narrowest part of the larynx through which air passes in and out of the trachea) following a full inspiration with expiration maximally activated (1). The effect of the Valsalva in which the breath is held during the entire lift has been described to some extent in Answer 1. Also, because of the pressure created, particularly in the chest cavity, the flow of venous blood to the right auricle is greatly hindered, and with significant tension it may be completely stopped (1). Blood in the lungs is quickly expelled, heart size is reduced, and heart volumes are sharply reduced. Arterial pressure increases and opening size of the arteries reduces helping arterial blood to reach the arterioles. However, with prolonged tension, blood accumulates in the venous system, breathing the supply to the brain, possibly bringing about loss of consciousness.

I would not recommend using the complete Valsalva. We use what we call a partial Valsalva. By doing this, we are able to take advantage of all of the positive aspects of producing pressure and tension and avoiding the more negative (e.g., black out) aspects. Our lifters are taught the Valsalva with one exception. They are taught to expire partially when they know they will be able to complete their particular lift. This also applies to lifts (usually multi-joint) of higher intensity. This expiration should occur when two-thirds to three-fourths of a concentric contraction has taken place.

3. Differentiate your recommended breathing pattern for a 1 RM squat/bench press/power clean.

Lander: Squat: 1) Tighten your abdominal cavity using your abdominal muscles (rectus femoris, internal and external obliques, transversalis), thus raising the IAP. A greater IAP allows you to better maintain a greater ITP due to a more stable diaphragm muscle at the bottom of the thoracic cavity. A weight belt will also help you increase ITP and IAP. 2) Take a breath and close your glottis. 3) Lower the weight under control while maintaining a stable trunk, especially at the lowest point of the lift. 4) Raise the weight and begin to exhale after you have passed through the "sticking region" or the most difficult portion of the lift. This should occur after a 90 degree angle at the knee has been passed. 5) Do not fully expire or destabilize the trunk until the weight has been racked.

Bench press: A similar pattern should be followed for this lift. 1) Take a breath and close your glottis. 2) Lower the weight under control while maintaining a full, firm, and stable chest. 3) Lightly touch the chest and raise the weights. 4) Begin exhaling after you have passed through the sticking region (approximately one half to two-thirds of the way through the lift). 5) Exhale completely after you have racked the weight.

Power clean: Like the squat and bench press, the power clean requires that you maintain a firm thoracic and abdominal cavity; therefore the pattern of breathing should be similar to the above. The exception is that the inhaling and closing of the glottis should be performed before the beginning of the pull. There may be enough time to catch a short second breath during a squat clean, but probably NOT during a power clean.

Austin: Squat: I recommend that the athlete take in a couple of deep breaths before taking the bar out of the racks. Once the athlete has properly set up, he exhales all the air out of his lungs. Just as he starts his descent in the squat, the athlete takes in several short spurts of air into the lungs, holding his breath throughout the movement and exhaling once he is near completion of the squat.

Bench: Once the athlete has positioned himself, as he is receiving the hand-off, the athlete inhales air into the lungs (expanding the chest). The athlete holds his breath as the bar is lowered to the chest. As the athlete presses the bar upward, he should exhale once he has pushed through the hardest part or near the top of the bench.

Power Clean: As the athlete starts his pull, he inhales air into the body by both nose and mouth, holding it until he has completed the lift at the top, then exhaling as the weight is lowered to the floor.

Palmieri: In all three movements, the squat, bench press, and power clean, during a 1 RM, I recommend that the breath be held during the lift. In both the bench press and the squat, a deep breath of air should be
proper breathing may be used to enhance the intensity of the movement. By exhaling as one begins the concentric contraction, completing the movement and being totally expired at the same time followed by holding the movement for a count may intensify the contractions. As you begin the eccentric movement you may begin to inhale.

7. How do you teach proper breathing to your athletes?

Kreis: By watching competitive swimmers, one can get the true meaning of proper breathing. Without proper breathing, the swimmer will go no where. In teaching proper breathing, you must remember the rhytmical breathing patterns.

Palmieri: As with any technique work taught for a weight training exercise, light weight should be used on the bar. I emphasize a slow, controlled movement of the bar, coinciding with a slow, controlled breathing pattern. Initially, the athlete will inhale while lowering the weight and exhale while raising the weight. I tell the athlete to imagine that he is blowing the weight upward. Once the breathing pattern is learned, heavy loads can be incorporated into the workout.

Roll: In order to teach proper breathing technique, the lifter must be able to distinguish between concentric/eccentric movement. They must also be shown proper technique.

Our athletes are taught when to inhale, how to use the glottis, how to create pressure in the abdominal and chest cavity (taking advantage of tension) and when and how to exhale. Consideration must be given as to when this occurs in varying lifts.

Austin: This is one of the most important sessions we teach to our athletes who are starting in our program. A lot of the athletes that come to us have little knowledge as to why breathing is important, or fail to realize they are breathing. The first thing we do is show them how to breath through their mouth and nose. We tell our athletes they should inhale at the beginning of an exercise, holding their breath until pushing through the most difficult part of the lift or near completion before exhaling. Some athletes will find this hard to do, so we will talk them through the breathing process with light weights.

8. What are some common breathing errors observed during weight training?

Lander: There is a common error in breathing technique used during the performance of sit-up or curl-up exercises. The purpose of these exercises is to train the flexor muscles of the trunk (rectus abdominus, internal and external obliques, transversalis). If you will stabilize the thoracic (trunk) region, in other words, make it stiff, and this is definitely undesirable when you are attempting to do an exercise which requires full mobility of the spine. For this reason, you should fully exhale before curling the trunk in abdominal flexion exercises. One may even recommend that the athlete use the transversalis muscle to "suck in" the stomach prior to flexing the trunk. By fully exhaling, you now have the opportunity to perform the exercise properly without having to resort to the hip flexor muscles, which is a common error in this type of exercise. Once again, a conscious effort should be made to breathe between each repetition. This effect should also be taken into account when performing trunk extension-type exercises. You must decide whether a stable trunk is desired by isometrically contracting the trunk extensor muscles as in the squat exercise, or whether you desire eccentric and concentric contractions of these muscles as in the back (hyper) extension exercise. Care must be taken when making this choice since the back is a common site for injuries to occur.

Roll: Some common errors in breathing would include holding the breath for too long (through the entire repetition as with 1 RM or for several reps as with 10 RM), which is extremely dangerous, especially when followed by hyperventilation. Also, holding the breath with the mouth closed versus the closed glottis may cause increased venous pressure, particularly in the cranium. This may increase the chances of ruptured vessels and blackout. Also, it is often observed that people do not understand breathing patterns during concentric and eccentric movement and its relationship in aiding correct technique.

Austin: 1. An athlete holding his breath while performing a set; not breathing at all. 2. An athlete exhaling before pushing through the most difficult part of a lift. 3. Players exhaling at the beginning of a lift. 4. Players inhaling and exhaling several times before completing a lift.

Kreis: 1. Breathing during a rep. This stops your body from exploding during a rep. 2. The hard breathing before a lift. Many spend too much energy even before the lift begins. Many are young lifters who are excited about the lift. 3. When an athlete gets so wrapped up in the lift, he/she does not concentrate on the breathing technique and form of the lift.
Palmieri: Not breathing or inhaling only a small volume of air is a common error often found in novice lifters. Additionally, the Valsalva maneuver is performed for too long of a period. Probably the biggest breathing fault that I have observed among inexperienced weight trainers is breathing out of sequence with the exercise. For example, the lifter may be inhaling when he ought to be exhaling, or vice versa. Furthermore, the rate of breathing may not coincide with the rate the repetitions are performed.

9. What might be the consequences of improper breathing?

Landor: Improper breathing may result in loss of consciousness due to reduced blood flow to the brain. Also, the great increase in blood pressure during the Valsalva maneuver may increase the risk of a burst blood vessel in some critical part of the body. It appears as though you would be better off if you didn’t need to interrupt normal breathing (using the Valsalva maneuver), but we must balance these risks against the need for a stable spine during most of our heavy lifts. So the question then becomes: How can you use breathing to your biomechanical advantage while minimizing the negative physiological effects? Hopefully, this question was answered by your reading of the roundtable discussion.

Austin: An athlete not breathing or breathing improperly can cause lack of oxygen to the brain which will cause the athlete to pass out. Also, in lifting, if an athlete exhales too soon, he can lose his tightness and miss a lift.

Kreis: A sharp rise in blood pressure, blacking out, and a lower rate of improvement.

"When an athlete gets wrapped up in the lift, he does not concentrate on the breathing technique and form of the lift."—Kreis

Roll: One drastic consequence of improper breathing is serious injury. In fact, failure to breathe may be fatal. Seriously, this could occur if a lifter were to black out in an overhead lift. Injuries could occur from the use of improper technique caused by improper breathing. This is often seen in squats and injuries to the lower back. On the same note, lesser performance as far as strength increases could possibly result because of prolonged use of improper breathing techniques. As discussed earlier, creating tension may increase contractile strength.

Palmieri: Stamford (5) writes that proper breathing affects one’s performance. Conversely, improper breathing could inhibit an athlete’s ability to perform. I have observed athletes developing severe headaches while lifting. This condition may result from the undue pressure placed on the blood vessels in the head due to the Valsalva maneuver. Stamford (5) has reported that blackouts may result from holding the breath too long, as well as erratic blood pressure (4). The latter is especially dangerous to the older athlete, or individuals with cardiovascular problems.

References for Roll

References for Palmieri

References for Lander