Hold & Hold Control

By Marcus Raab, Assistant National Rifle Coach

Hold is a deceptively simple fundamental to describe. It is easy to say a good hold is one that has a small movement area oriented at the reference point (i.e., center of the target) and is stable and durable enough to allow smooth trigger control. It is much more difficult to fully define hold since it is so interrelated to all the other fundamentals and aspects of position, physical conditioning and mental skills. And it is even more challenging to actually develop and maintain a high quality hold for the shooter to execute the shot.

Shown below in Figure 1 are hypothetical holds for prone and standing. While some people can hold a sight picture that appears motionless, there is always some movement even in the prone position. It is often quite difficult to see this movement without some kind of aid. A telescopic sight which magnifies the target, for example, can show how much movement there really is in the shooters position. Athletes must learn to accept this movement and execute correct trigger control without disturbing or negatively influencing the sight picture. Even the shooter has trouble seeing the entirety of the movements, perhaps remembering only the last few instants before the shot is fired. This, of course, is enough to know where the shot should have hit the target, but insufficient to really analyze the holding ability.

Previously the only tool the coach had to evaluate the holding ability of shooters was his or her own eyes. You can still do that by standing behind the athlete and lining up the edge of the barrel or front sight tunnel with an object (e.g., another target) downrange. The challenging part is for the observer to stay still enough so that the only movement seen is that of the rifle muzzle. Recoil of the rifle also masks some aspects of the hold, especially follow-through.

Though expensive, computer training systems are available on the market; notably the Scatt, Rika, Noptel and others that can record the precise orientation of the rifle in relation to the target. What is so eye opening about these systems is that they allow the coach (and shooter) to actually see what is happening throughout the whole shot process. You can not only see the result of a shot after it has been taken but also what happened while aiming at the target, both before and after. Graphs produced from the mathematical analysis of the series of shots can help identify problems and lead to the best course of action to take regarding improvement. These systems work in either a dry fire mode or may be used live fire with pellets at 10 meters and even longer ranges depending on features.

The use of these training systems is almost essential for top-level performance as they can show such fine detail and the tiny mistakes that elude detection other than showing up as nines on the target. Even for the developing shooter, a visual depiction of how it should be done (with the opportunity to emulate the top shooters around the world) can significantly shorten the learning curve.

On the next page, there are Scatt traces (Figures 2, 3 and 4) of three different air rifle shooters showing the approach and hold up to the moment of the shot. The intermediate-level shooter has little control of his or her alignment with the target, forcing the rifle toward the center as well as a larger hold area. The advanced athlete shows better control over alignment and a smaller hold area, but the trace also indicates

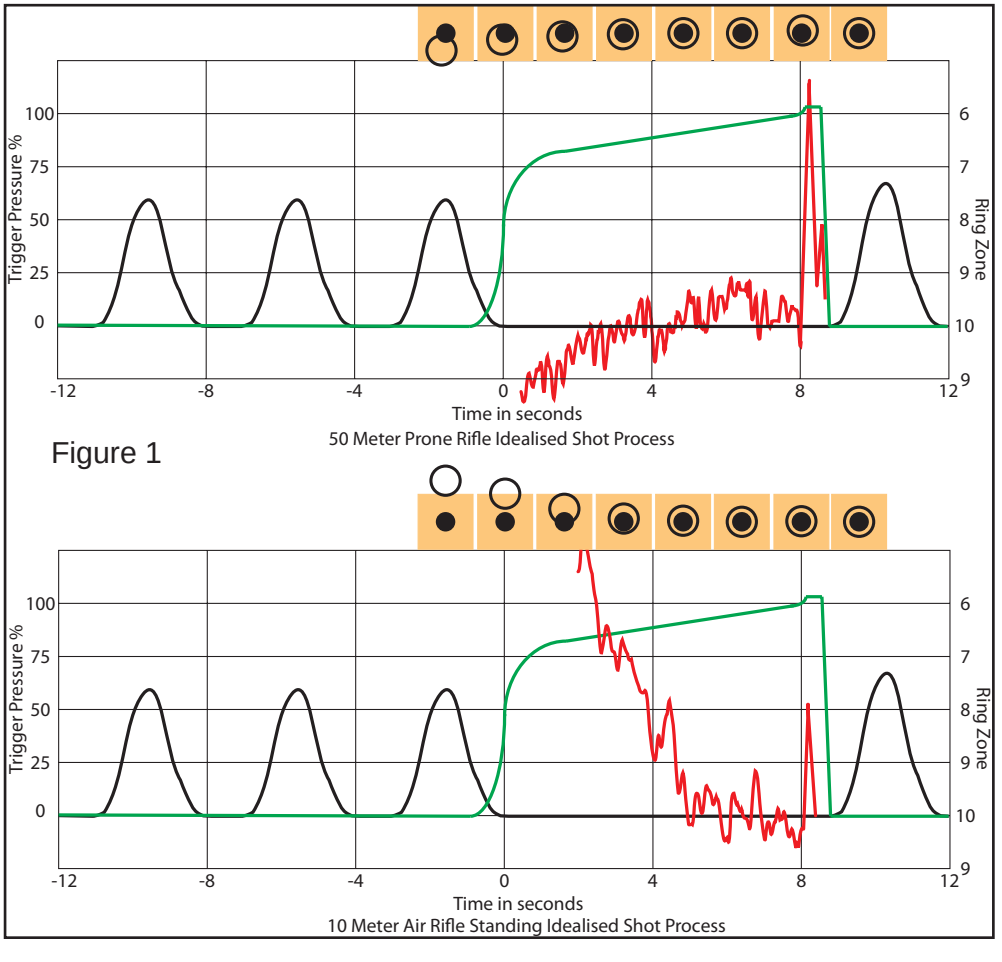
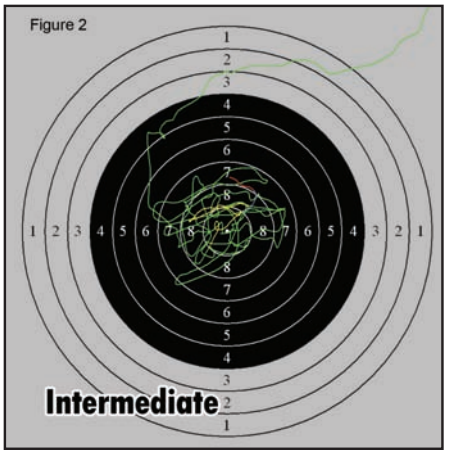
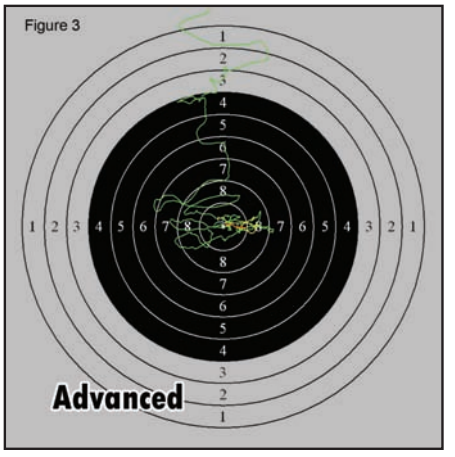


Figure 1





the possibility of tensed muscles. Notice the sharp changes in direction that overcompensate to the other side—this occurs when the shooter sees that the sights are not quite centered and nudges the rifle toward the center. Results: Intermediate = 8; Advanced = 9.

As a comparison, this Scatt trace shows the hold of an elite air rifle shooter up to the moment of the shot. This athlete has excellent control of his or her positional alignment, which allows the hold to settle directly into the center and stop in the middle of the target. The small hold area illustrates relaxed muscles with no need to force the rifle toward the center (it is already there!). This hold looks almost motionless to the shooter. The result? A deep 10! This is what we all would love to see, but again it requires lots of training and practice.

Biomechanics

Biomechanics is the sport science field that applies the laws of mechanics and physics to that of human performance. It is used to gain a greater understanding of athletic performance through modeling, simulation and measurement. It is necessary to have a good understanding of the application of physics to sport, as physical principles such as motion, resistance, momentum and friction all play a part in rifle shooting.

What factors contribute to hold?

So how does a shooter progress to an elite quality hold; one that is small, centered, stable and durable? The most critical component of holding ability is a biomechanically sound position. The movement will vary in size and predominant movement pattern with each position, with supported or sling positions being relatively stable and durable, while standing is less stable. Each position presents its own challenges. Nevertheless, there are some principles that apply to all positions. It is how well these principles are applied that determines success in each position. The elements of a sound position and its development are:

- Bone Support
- Balance
- Natural Point of Aim & Alignment
- Comfort
- Consistency
- Legality

Skeletal Structure and Bone Support

The human skeleton consists of both fused and individual bones connected, supported and supplemented by ligaments, tendons, muscles and cartilage. It serves as the framework that supports organs, anchors muscles and protects critical organs such as the brain, lungs and heart. An array of differing joint types allows the muscles to move the body to perform tasks.

You have, no doubt, tried to hold something still at arms length. You were probably successful at first, but at some point you could no longer hold the object still and eventually your arm would finally reach the point where it could not remain in position no matter how hard you tried. Muscles, even strong muscles, will fatigue and not respond in the predictable way needed for the ultra-fine motor control necessary to execute the shot precisely. Whereas the bones of the skeleton do not suffer the same problem of fatigue and may be used almost indefinitely as the structural elements of the shooting position. In rifle shooting, with heavy guns and long courses of fire, maximizing bone support is an important aspect of developing a good position and hold. Without some minimal amount of muscle tension, however, we would be unable to maintain the skeleton in the same orientation.

Statics and Stability

When building a shooting position coaches must take into consideration the bones, muscles and other body structures and organs. Additionally, the proportions of the shooter's body, long or short arms, long or short legs, long or short torso and neck and the flexibility of the joints play a role in determining the best position for a specific shooter.

We seek to position the body to maximize the support of the bone structure while also minimizing the use of muscle force. This is best accomplished by placing the body parts that support the rifle position into vertical planes. For example, when a carpenter is creating a strong structure, he or she installs the walls in a vertical fashion to best resist the forces

of gravity. If the walls were built at an angle and there is a large snowfall that weighs down the roof, it is likely that the building would either collapse or require additional support (the use of muscles) to remain standing.

The same is true for shooting positions. For the body to remain stable in the shooting position, the legs and arms that support the rifle must form vertical planes. This transmits the weight of both the rifle and body directly into the ground without the need to use muscle. While the sling plays a major structural role in helping support the prone and kneeling positions, shooters still need the bones in the proper orientation to maximize support. A coach must thoroughly understand this concept and be able to identify and correct positional errors when observed. The areas that you need to pay attention to are specific for each of the positions.

Balance

From a biomechanics perspective, human balance refers to the body's ability to maintain an upright posture by keeping the center of mass (gravity) positioned over the base of support with minimal postural sway. This may involve a fixed base (for standing) or a moving base of support (for walking or regaining balance after a slip). Balancing ability can be studied using ground reactions (force patterns at the foot-floor interface), body segment kinematics (motion of upper/lower extremities) and electromyography (electrical signature of muscles when contracting).

When discussing balance, we will only address a fixed base (in addition to the weight of the rifle and accessories) of support since shooting is a static sport.

Standing, for example, is a human position in which the body is held upright and supported only by the feet, referred to as an orthostatic state as shown in Figure 5. In the case of an individual standing upright quietly, the limit of stability is defined as the amount of postural sway when balance is lost and corrective action is required. The limit of stability may be described by an irregular conical envelope above the support base. This limit of stability far exceeds what is acceptable balance for the shooting position.

Although standing per se is not dangerous, there are a few pathologies associated with it. One short-term condition is orthostatic hypotension, or low blood pressure when standing, which is caused by gravity pulling the blood into the lower part of the body. Because the brain does not get sufficient blood supply, it can result in dizziness, lightheadedness, headache, blurred or dimmed vision and even fainting. Longer-term conditions are sore feet, stiff legs and low back pain.

While we have been focusing on standing, both kneeling and prone require balancing as well. Kneeling has a larger base of support than standing but less than prone. Even then, the kneeling position is balanced between the right foot, the kneeling roll and left foot. In prone the rifle is balanced on the left arm.

Figure 5

Figure 5 shows the support area and center of gravity. The man on the right shows a loss of balance when the center of gravity moves outside the support base.

Nervous system

The human center of mass is in front of the ankle, with a narrow base of support, consisting of only two feet. A truly static pose would cause a human to fall forward onto his or her face. In addition, there are constant external stresses (such as breezes) and internal stresses (respiration, digestion, excess water temporarily stored in the bladder, etc.).

Maintaining an erect posture relies on dynamic rather than static balance, which requires constant adjustment and correction. The nervous system continually and unconsciously monitors our movement direction and velocity as the body's vertical axis alternates between tilting forward and backward and side to side. Before each tilt reaches the tip-over point, the nervous system counters the imbalance with a signal to reverse direction. The muscle exertion required to maintain an aligned standing posture is generally minimal but crucial, with the muscles of the feet and ankles are intimately involved in balancing. The muscles of the calves, hips and low back also play a small role. However, recent attention has been devoted to the core muscles, as they are critical in maintaining stability. The transverse abdominals, or the internal core muscles that lie close to the spine, function as a compression corset and provide structural support and control. Dysfunction or imbalance of the core muscles is also associated with back pain. With rifle shooting positions being one-sided, the risk of developing an imbalance in strength and/or flexibility is increased. It makes sense, therefore, to improve overall core muscular strength, along with the legs, to help stabilize the standing and kneeling positions.

Balance control

Controlling this dynamic balancing process requires simultaneous processing of inputs from multiple

senses. This includes equilibrioception (from the vestibular system located in the inner ear), vision and proprioception (the body's sense of where it is in space). The senses detect changes of body position with respect to the base while the motor system controls muscle actions to maintain balance.

The vestibule is the region of the inner ear where the semicircular canals converge, close to the cochlea (the hearing organ). Each semicircular canal has a bulbed end, or enlarged portion, that contains hair cells. Rotation or tilting of the head causes a flow of fluid, which in turn causes displacement of the top portion of the hair cells that are embedded in the jelly-like cupula. Two other organs that are part of the vestibular system are the utricle and saccule. These are called the otolithic organs and are responsible for detecting movement in a straight line. The hair cells of the otolithic organs are blanketed with a jelly-like layer studded with tiny calcium stones called otoconia. When the head is tilted or the body position is changed with respect to gravity, the displacement of the stones causes the hair cells to bend, which in turn sends signals to the brain.

The balance control system also utilizes visual input to maintain orientation and balance. For example, visual signals are sent to the brain about the body's position in relation to its surroundings. These signals are processed by the brain and the information is compared to reports from the vestibular and the skeletal systems. An erect head position is the key to maintaining balance. Not just for the balance apparatus in the inner ear, but also for the eyes and vision. The importance of visual input for balance is illustrated by the fact that it is harder to stand on one foot with eyes closed rather than eyes open. Another example is a swaying spotting scope or rifle rest stand, seen in a shooter's peripheral vision, creating rhythmic swaying of the shooter.

The third component of balance control is proprioception. It is the third distinct sensory mode that provides feedback and indicates whether the body is moving with the required effort. Additionally, proprioception detects where the various parts of the body are located in relation to each other. Proprioceptors on the bottom of the feet, for example, sense the pressure as it changes from the shift in the center of gravity.

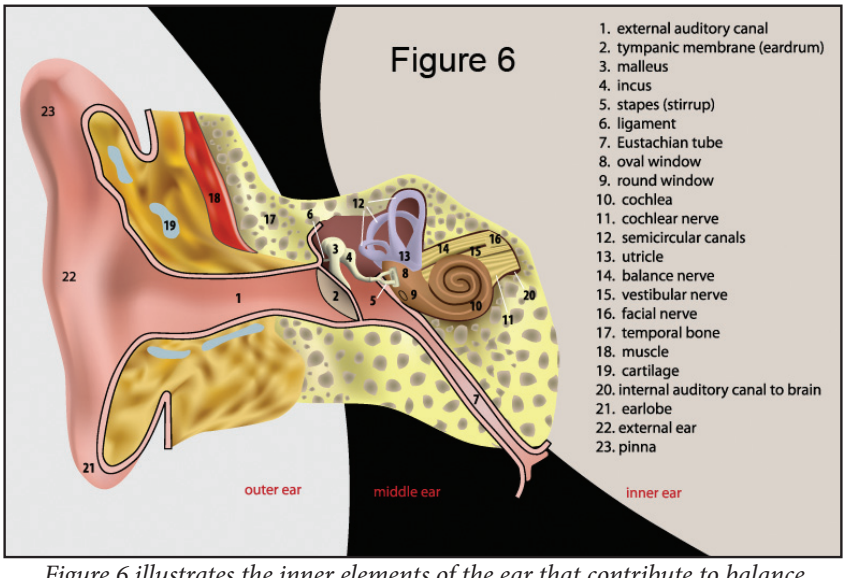


Figure 6 illustrates the inner elements of the ear that contribute to balance.

The sense of balance usually deteriorates in the aging process. However, it can be improved considerably with the help of specialized training.

Natural Point of Aim and Alignment

Often a confusing point for beginners and experienced shooters alike, Natural Point of Aim (NPA) has nothing to do with the target. It is where the rifle naturally points when the body is relaxed. The objective is to adjust the position so that the rifle points naturally at the target center when the body is relaxed. Alignment to the target is correct when the body is in a relaxed position supported by bone structure (with minimal muscle tension) and the rifle naturally points exactly at the center of the specific target. Alignment is not just left and right, but up and down as well.

"How do we check NPA?" (Note: There are several methods to check NPA. The suggestion below is only one such method.)

- Relax with head on the stock
- Close the eyes or glance away
- Check balance & muscle tension
- Open eyes & see where rifle is pointing
- Make needed adjustments & test again

Check-adjust, Check-adjust, Check-adjust, Check until it is perfect. Adjustment mechanics are different for each position but the goal is the same.

NPA should be checked every shot as an integral part of the whole shot process. If the NPA is aligned correctly, the shooter will see the rifle sights approach the target from exactly the same direction, and then slow and stop exactly on the center of the target. The shot can then be fired with confidence.

When alignment is not correct, the temptation is to engage the muscles to push the sights to the center. This results in poor shots as the rifle will move away from the center as the shot is fired. Consider, for a moment, if the NPA is exactly centered and the shot is released on the outside of the hold area, the rifle will tend to move toward the center. A better shot is the result. This is the reason for checking alignment until it is perfect.

Comfort

All shooting positions should be reasonably comfortable. Some discomfort is inevitable, especially during beginner training or after a long layoff from shooting, but within a few minutes of getting out of position the discomfort should disappear. Early

training sessions should be intentionally short so that the shooter can build up a tolerance to the pressures of the sling and kneeling roll. Pain, however, is never a good sign and may indicate an injury or other problem. If the shooter is in pain, stop immediately and apply appropriate first-aid. Before allowing the shooter to continue, make certain that any issue has been resolved.

A good position allows normal flow of blood between the heart, head, arms and legs while shooting. Some restriction of blood flow and impinging on the nerves of the arm may occur when using a sling, but that can be somewhat alleviated by wearing thick sweatshirts or undergarments and a shooting jacket with a properly adjusted sling.

The kneeling position can also restrict blood flow to the leg and also impinge on the nerves that pass behind the knee. Comfort can be improved in the kneeling position by spending time in position on the kneeling roll while engaged in some other activity like reading or watching television. Building up the time that the shooter can comfortably stay in position will make it easier to stay focused on shooting instead of thinking how bad their foot and ankle feels. Stretching and flexibility exercises can also help improve overall comfort.

Consistency

In rifle shooting, we are trying to place one shot on top of the other in the center of the target. The only way to accomplish that task is by having a solid position that allows the shooter to continually reproduce the same shot process. Without being consistent, the chances of performing successfully are low.

Consistency is not just shot-to-shot, or even series-to-series, but also day-to-day. After the basics are learned, next to come is the introduction and development of the shot process or routine. As the athlete enters competitions, a setup routine is also needed. It all boils down to repetition in thought and action as trained.

Legality

Of course any position used in competition must comply with the rules. Rulebooks are generally quite consistent on what constitutes a legal shooting position, but it never hurts to keep up to date on with the fine points of the various rules. It would make no sense to develop and learn a position that would be in violation of the rules. Yet we see these violations too frequently.

For example, in the prone position, the left arm must form a 30 degree angle with the supporting surface and the sling may not touch the gun or shooter except at the attachment points. In standing, the rifle may touch the upper chest and shoulder area only on the dominant side of the body. And in kneeling, the roll may not be used if the dominant foot is at more than a 45 degree angle and the point of the elbow must not be more than 10 cm over or 15 cm behind the point of the other.

Coaches must be ever vigilant that changes to a shooter's position do not violate the competition rules. In many cases, subtle adjustments made over time can suddenly result in a position that is no longer legal. Don't let this happen to you.

Psychological Interconnectedness

Holding still or hold control is as much about the mental efforts used to reduce or control body movement as it is the physical positioning. Conscious thought about correcting the aim almost always results in over-correction of the error and a jerky response. Movement of the rifle can be somewhat controlled by turning one's attention inside the body through the inner position. Ask yourself questions such as: "Muscle tension, is it correct? Where is it too much?" Breathing, as we discussed earlier, helps control emotions, relaxing both the body and mind and reduces unneeded muscle tension. A small change will stand out if the background tension is low.

The mental control of the hold, however, is more about the focused thought or intention of "smaller," "slower" or "center" and will likely be more productive than consciously trying to correct or adjust the hold while aiming.

Top-level shooters from around the world describe this mental control of their position, and thus their hold, in a wide variety of ways. From that of being a granite statue or leaning up against an imaginary wall to resting their elbows on imaginary tables at just the perfect height or holding themselves in the perfect position with an imaginary corset; whatever the mental key, these shooters exert their will to hold still. Essentially it is mind over matter.

All of these images, and more, have been used successfully. It is, of course, a very personal choice and no one should be forced into any specific trick described here, but rather given the idea and the freedom to test and develop their own best solution to holding still.

Of all the fundamentals, holding the rifle confidently on the center of the target is the most critical for shooting success. Everything else follows from that. But without being able to execute the shot, the best hold in the world is useless.

Outer Position

The position of the body and all of its parts along with the shooters clothing and accessories constitute the outer position. For example, in the standing position, the coach can observe the orientation of the hips in relation to the feet and legs, the angle of the arms, back and torso, and how the shifting of weight toward the target tilts the pelvis and provides a shelf to rest the elbow. The coach can also see how the clothing fits and whether it helps or hinders the shooter in obtaining the correct body position. Essentially, it is anything and everything an observer can see.

Inner Position

While the outer position is what the position looks like from the outside, the inner position, is fairly invisible to the observer. Even the shooter is not necessarily aware of what the right feeling should be. What the coach cannot see is the feeling, the muscle tension and the discomfort. A biomechanically sound position, practiced consistently, provides feedback to the brain of the correct feeling of a solid position. Ultimately, however, the ability to precisely replicate the exact same position shot-to-shot and day-to-day is gained over several years of training.