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Bilateral vascular restraint – Facts and myths of the carotid restraint

Carotid restraint, a grappling technique sometimes correctly or incorrectly known as the carotid hold, blood choke,vascular hold, lateral vascular restraint, carotid sleeper, arm bar choke, strangle hold, headlock, and a variety of other names, is one of the restraint techniques utilized by the law enforcement community.

This technique is primarily utilized by law enforcement to obtain compliance in resisting subjects. As a restraint hold, the carotid restraint has the unique feature that it may induce rapid loss of consciousness. As suggested by its name, a common misconception is that carotid artery occlusion is the primary and only mechanism responsible for the rapid loss of consciousness.

Unlike this traditional idea, the causes of rapid loss of consciousness and other clinical effects observed with carotid restraint include multiple systems. This article examines the effects of carotid occlusion and introduces two other significant mechanisms, jugular venous occlusion and vasovagal neurological stimulation, causing the rapid loss of consciousness.

Due to the potential confusion about its names and techniques, this article clarifies the proper carotid restraint technique for law enforcement application and uses the name bilateral vascular restraint (BVR), which is more accurate technically and physiologically. With the application of BVR, the clinical effects observed are due to three major physiological mechanisms, and they include carotid artery occlusion, jugular venous occlusion and neurological stimulations. Although carotid artery occlusion is the most publicized physiological mechanism, the less publicized physiological mechanisms of jugular venous occlusion and neurological stimulation have equal, if not more important, roles. It is a common misconception that airway obstruction is a major contributor to the effectiveness of carotid restraint. In a properly applied BVR technique, the airway is minimally involved.

Syncope

Syncope is a medical term for sudden transient loss of consciousness. Unlike other grappling techniques, BVR has the unique feature that it may induce syncope in its subjects. The current law enforcement perception of syncope caused by carotid restraint is carotid artery occlusion leading to diminished brain perfusion and cerebral hypoxia, which is the lack of oxygen to the brain. However, a review of literature and clinical observations suggest that most of the clinical features observed with BVR are due to jugular venous obstruction and vasovagal neurological stimulation. In order for a person to lose consciousness due to brain dysfunction, the brain either has to sustain a global event affecting both sides of the brain or sustain a focal injury to the brainstem. In the medical community, vasovagal stimulation is a well-known leading cause of syncope and has the physiological effect of the sudden global drop of blood pressure and heart rate (perfusion) throughout the body.

Carotid arterial and jugular venous occlusions

In a simplified view, two carotid arteries and two vertebral arteries jointly supply oxygenated blood to the brain. Under normal circumstances, the carotid arteries supply about 75% of blood flow to the brain, and the vertebral arteries supply the remaining 25%. These four arteries join together in the brain to form a circular vascular bed called the Circle of Willis, which supplies blood to all parts of the brain. Unless all four of these arteries are occluded simultaneously, there would still be a continued supply of blood, though less, to both sides of the brain via the Circle of Willis as a collateral circulatory system. Even if both carotid arteries are completely occluded, the vertebral arteries protected by the bony spinal column continue to deliver blood to the brain.

The jugular venous system is responsible for returning blood from the brain back to systemic circulation. Jugular venous occlusion will decrease the blood perfusion to the brain by backing up the blood flow. As a low-pressure system with easily compressible vascular walls, the jugular veins are much more prone to occlusion than carotid arteries, which have higher pressures and stronger walls. As reported in forensic medicine literature, only two kilograms of tension on a ligature around the neck is needed to block the jugular veins, resulting in stagnant cerebral hypoxia. At any pressure, a BVR induces far more occlusive effects on the jugular veins than on carotid arteries.

This clinical effect is supported by the development of facial petechiae, often observed in victims of manual strangulation and hanging. Isolated arterial occlusion would not have the clinical sign of petechiae, which is due to vascular congestion. Arterial insufficiency has the physical signs of lack of arterial blood flow, such as pale discoloration, decreased arterial pulses, collapsed venous system and symptoms of pain, numbness and weakness.

Petechiae are a common clinical finding associated with forceful and violent occlusions of the neck such as manual strangulation, partial suspension hangings and ligature strangulations. As documented in forensic pathology textbooks, petechiae are a mechanical vascular phenomenon due to obstructed venous return in the presence of continued arterial flow. Petechiae tend to occur in soft tissue areas with little surrounding connective tissue support. The likelihood of occurrence of petechiae is proportional to the degree of venous obstruction and inversely proportional to the degree of arterial compression.

When the jugular veins are occluded, blood is congested in the head. This venous congestion can lead to poor brain perfusion and hypoxia due to the inability of blood to move forward in the cerebral circulation. The net effect is similar to the occlusion of the forward blood flow of the carotid arterial system. This venous occlusion mechanism correlates with the clinical effects of facial flushing, distended veins above the point of occlusion and conjunctival petechiae observed with carotid restraint techniques in the past. Conjunctival petechiae are a sign of significant vascular congestion and require an unobstructed arterial system and an occluded venous system. Hypoxic damage to the capillaries is not a likely mechanism for petechiae.

Neurological stimulation

Although neurological stimulation is not well-publicized, it has profound clinical effects in the application of BVR. Both sympathetic and vasovagal stimulations are discussed in this article; however, vasovagal stimulation is the major mechanism contributing to the rapid onset of syncope as observed with BVR.

In law enforcement situations with close physical confrontation, tremendous physical and emotional stresses are placed on both the officer and subject. For the subject, an adrenal or "fight and flight" sympathetic reflex increases heart rate, blood pressure, muscle tone, hyperventilation and other stress responses. This physiological response is "situational appropriate" and assists the subject in sustaining his or her struggles.

On the other hand, vasovagal stimulation is a neurally-mediated phenomenon which causes sudden slowing of the heart (bradycardia), a drop in blood pressure (hypotension) and may lead to fainting, which is commonly known as vasovagal syncope. Pressure placed on the carotid sinus is the trigger point for vasovagal stimulation during BVR.

The carotid arterial system has built-in pressure-sensing organs called carotid sinuses which are located near the carotid bifurcation in the mid-neck region. As a pressure-sensing organ, it regulates the blood pressures via neurological pathway. Upon detection of increased intra-luminal pressure, a neurological signal (vagal tone) is sent from the carotid sinus via the parasympathetic nervous system to the heart and rest of the vascular system with the overall clinical effects of decreasing the blood pressure and slowing down the heart rate.

As external pressure is applied to the neck region by BVR, carotid sinuses in the neck sense this increase in pressure and reflexively augment the vagal tone via vasovagal reflex, which slow down the heart and drop the systemic blood pressure. In sensitive individuals, minor events such as turning of the neck, shaving of the neck region, and even wearing shirts with tight collars may trigger syncope. This pressure stimulation of carotid sinus has been utilized by the medical professionals in a maneuver called the carotid sinus massage where external pressure is applied to carotid sinus with the goal to slow down life-threatening tachydysrhythmia (abnormal fast heart rate).

In addition to the occlusion of jugular veins and carotid arteries, vasovagal reflex significantly potentiates the clinical effects of brain hypoxia by causing sudden global drop of blood pressure, heart rate and perfusion throughout the body. With a sudden drop in the systemic blood pressure and heart rate, both the carotid and vertebral basilar arterial systems are affected at the same time. In contrast to the adrenal fight and flight reflex, the vasovagal physiological response is "situational inappropriate" and can decrease the fighting capacity of the subject and lead to a rapid loss of consciousness.

In a past well-quoted research study, carotid restraint was applied to volunteers until the volunteers had almost lost consciousness. Vital signs and indirect measurement of arterial flows were measured during the application of carotid restraint. A review of the data by the authors concluded that carotid artery occlusion was the major mechanism for syncope due to carotid restraint; however, a closer look at the data from this study actually showed that vasovagal neurological stimulation was the only factor associated with the most rapid time to minimum blood flow and to the endpoint of near-syncope. Just before the application of the carotid restraint, all volunteers showed relatively fast heart rates (range from 90 to 115) which was expected due to the subject's conscious anticipation of an unpleasant procedure. With the application of carotid restraint, three out of five subjects had a sudden drop in heart rate (from 90 to 70, 90 to 58, 90 to 65) which the author appropriately attributed to vasovagal response. Of interest, the subjects who had vasovagal responses also had the most rapid time to minimum blood flow (3.2, 4.2 and 4.8 seconds vs. 7.0 and 7.2 seconds in volunteers without vasovagal responses).

If carotid artery occlusion was the only mechanism leading to syncope during BVR as suggested by the authors of this study, one would expect a predominantly sympathetic response with increase in heart rate and blood pressure due to conscious participation of this unpleasant procedure. The data from this study actually demonstrated that the causes of syncope due to BVR were due to multiple systems, and vasovagal reflex neurological response is a strong modulator leading to rapid loss of consciousness.

Airway obstruction
With properly executed BVR, the upper airway should be well-protected from permanent injuries as the pressures from BVR are directed to the lateral neck regions. The relative rigid structures of the anterior neck, such as the trachea, thyroid cartilages and cricoids should be well-protected by the opening of the officer's antecubital space. When BVR is applied, the subject may experience a choking sensation and difficulty with speech and breathing which is due to temporary posterior displacement of the tongue and other upper neck soft tissues.

Although significant compression of the upper airway is not an intended mechanism of BVR, it is important to evaluate upper airway integrity as injuries may occur during real life BVR applications, especially when the subjects are physically violent; their struggles can lead to unintended permanent injuries to their own upper airway. As part of the medical clearance for all subjects of BVR, the upper airway must be examined in detail to ensure there is no significant or permanent injury to the upper Airway.

BVR technique
Due to potential misnomer and misrepresentation of a proper law enforcement carotid restraint technique, the recommended BVR technique is specifically outlined in this section. Typically, each law enforcement agency has in place the general defensive tactics, such as proper distance, footwork and approach, which are to be considered when applying a control hold; therefore, these general techniques will not be discussed here. There are several elements in the tactical application of the BVR that distinguishes it from the use of other carotid-type holds. Inherent in the use of any level of force is the risk of injury to the resisting subject, but adherence to the following tactical considerations should maximize the effectiveness and safety of the BVR:

1. The officer should minimize the risk of injury when applying the BVR by immediately locking and applying maximum pressure to the sides of the resistor's neck. This lessens the possibility of the officer's encircling arm slipping out of correct alignment and inadvertently applying pressure to the resistor's airway during the struggle.

2. To ensure proper placement of the encircling arm, the officer must ensure his/her side is placed firmly against the back of resistor at an approximate ninety-degree angle. If the officer and resistor are facing in the same direction, or if there is a gap between the officer's body and resistor's body, it is likely that pressure will be improperly applied to the resistor's airway.

3. The BVR should not be applied in stages in which pressure to the sides of the neck is incrementally increased based on the actions of the resisting subject. Dependent upon each agency's use-of-force policy, once an officer determines a significant threat exists to warrant the use of the BVR, it makes little sense to apply lesser force than is necessary for an effective restraint hold. To do so unnecessarily endangers the officer, subject and innocent bystanders by permitting the subject to apply a number of possible countermoves and converting a properly positioned BVR into a potentially deadly hold with airway compression.

4. The officer can enhance the lateral neck pressure applied by the BVR by bringing his elbows together and down while simultaneously expanding the chest by arching his back.

5. The officer should immediately take the balance of the resistor to the rear and all the way to the ground and continuously keep the resistor off-balance to minimize the opportunity to counter the BVR. If the resistor is allowed to remain standing, a number of countermoves exist which would defeat a carotid-type restraint.

6. The officer should maintain balance and proper posture while ensuring the resistor is unable to execute a head butt.

7. The officer maintains pressure with the BVR until the resistor complies and is handcuffed or is rendered unconscious and restrained.

Recommendations

Based on a retrospective review of in-custody deaths related to carotid restraint, a pattern of practices was observed commonly in these deaths. A recommended guideline is made on the practice and management of BVR restrained subjects to maximize safety.

By definition, BVR is a technique applied only with the arms of the officers. No instruments, hard or soft, should be utilized. With the application of batons, flashlights, ropes and other objects, the restraint technique is no longer that of BVR. The above recommended BVR technique should be followed without modification. BVR should be applied until the resistor complies and is handcuffed or is rendered unconscious and restrained. Releasing a resisting subject prior to full control is dangerous to both the officer and subject.

A resisting subject who has significant pain, signs and symptoms of airway compromise, loss of consciousness, or unexplained alteration in mental status should be taken to the hospital for a full evaluation. Many BVR-restrained subjects are high-risk for medical complications such as excited delirium, which is a frequent cause of in-custody deaths. If in doubt, the BVR restrained subjects should be evaluated in a hospital setting and managed aggressively to rule out any existing or pre-existing life threatening condition. If there was no significant application of force (such as that utilized in a training setting with a volunteer subject), the BVR subject who rapidly became compliant and complained of no obvious injury might not need to undergo a hospital evaluation.

If the subject becomes unconscious, it is recommended that the person be restrained and placed in the lateral decubitus position (law enforcement recovery position) and handcuffed. This law enforcement recovery position prevents occlusion of the airway by the tongue and oral secretions, prevents aspiration, allows good blood perfusion to the upper part of the body including the brain, and permits good chest and air movements.

It also should be noted that an unconscious BVR subject should not be placed in an upright position (including sitting position such as in the back seat of a patrol car). With vasovagal reflex, an unconscious BVR subject may have situational inappropriate slowing of the heart rate and a drop in blood pressure. By placing an unconscious BVR subject in an upright position, the subject's brain (as the highest point of the body) may sustain prolonged inadequate blood perfusion. Often within seconds or minutes of releasing the BVR, the subject will regain consciousness and be able to tolerate sitting or standing.

The procedure of hogtying the subject, placing the subject facedown or completely covering the subject's face by pillows or other objects are high-risk for in-custody deaths, especially if the subject is unconscious. These procedures should be avoided when possible or corrected to safer positions as early as possible. Unconscious subjects and subjects with altered mental status should be directly observed and monitored throughout the recovery, and it is recommended that at least one person monitor and observe the subject until full recovery.

As soon as the subject is identified to be in need of hospital evaluation, emergency medical services (EMS) should be activated to provide medical transport to local hospitals. If EMS is not readily available, officers may choose to transport the subject directly to a local hospital with at least one person assigned to directly observe and monitor the subject. If possible, the monitoring person should have basic medical training, such as a law enforcement tactical medic. The subject should be properly handcuffed and restrained at all times and during the transport.

Conclusion

BVR can effectively and rapidly immobilize a subject and has the unique property of inducing loss of consciousness.

The application of BVR does not require exceptional strength and takes advantage of the stronger flexor muscles of the arms (compared to the extensor muscles of the arms and neck muscles). Like any other restraint technique, BVR is not risk-free. When distance and timing allow the utilization of other less-lethal forces, such as verbal de-escalation, neuromuscular incapacitation device or chemical agents, law enforcement officials should be encouraged to utilize these means. If officers are in close physical proximity to their subjects without the distance and timing allowed for other less-lethal forces, BVR can be an effective less-lethal restraint option to protect themselves and the subjects. When properly applied, BVR is effective and safe and can minimize injuries to the subjects, bystanders and officers.

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Improper positioning of the officer's arms. Her forearm is directly over the subject's thorax which would result in an air choke and not a BVR.

Correct positioning of the arms for BVR. Note how the officer's elbow is directly over the subject's throat. There is minimal danger of applying pressure to the trachea.

Officer begins to take the subject's balance to the rear by placing her foot on his knee and pressing forward and down.

Another option to break the subject's balance to the rear is for the officer to thrust her hip into the small of the subject's back.

Proper position for BVR application once the subject has been taken to the ground. Note the officer has her legs spread in a "bicycle" fashion with low, wide base to prevent the subject from rolling or escaping.

If additional threats are present in the area, the officer can assume an upright kneeling position and maintain a good visual of her surroundings. To maximize her stability, the officer has spread her knees to form a stable, low and wide base.