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Management of Gunshot Wounds

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INTRODUCTION
With the increasing number of hunting accidents and gunshot wounds seen by the practitioner it is important to know the result of wounds created by different types of firearms. This information is of value to both the small and large animal practitioner. Most of the literature available comes from publications of human war wounds in Vietnam, the Korean conflict, and World War II. The wound will vary as to the type of firearm used (high velocity vs low velocity), the trajectory angulation, and distance between the firearm and target. The type of ammunition used, its mass, and velocity are also factors that should be considered. The specific gravity of the tissues involved may also influence the extent of the injury. There is no one treatment regime in the management of these wounds, and each case should be treated as a separate entity.

FACTORS INVOLVED
Frequently when an animal is presented to the practitioner the owner is unaware that the animal has been shot. This is either due to very small pellets not easily seen, or defects that are created by high velocity weapons or close range gunshot wounds that resemble injuries the animal could receive by being hit by a car.

Gunshot wound are created by three types of firearms: pistols or civilian firearms, shotguns, and military or high powered hunting rifles. There is much controversy as to the definition of low vs high velocity (feet per second) firearms.

A low velocity missile can range from a revolver bullet traveling 600 feet per second (fps), or a pistol bullet (846 fps), to a .22 long rifle bullet (1206 fps). Shotgun blast velocity varies with the pellet size and the range at which the gun was fired. Military or high powered hunting rifles are considered high velocity weapons (over 2000 fps).1 Pistols and civilian firearms (low velocity) produce less distraction than high powered or military rifles which create severe soft tissue damage.

Damage to the tissues by a low velocity missile is the result of immediate displacement by the projectile. This usually results in a laceration and crushing of tissue with minimal cavitation with the area of damage being confined to the permanent cavity perimeter.2

Kinetic energy is proportional to mass and to the square of the velocity. Hence those factors that influence the velocity will have a greater effect on the kinetic energy than the mass does, as seen in the kinetic energy theory formula.4

\[ \text{Kinetic Energy} = \frac{\text{mass} \times \text{velocity}^2}{2} \]

Shotgun charges leave the barrel in a cone-shaped pattern. Shotgun wounding capability is a spectrum, ranging from a wound caused by a solitary pellet to one caused by the entire charge. The shotgun was developed to kill fast moving game. The fact that the shot contains many small spheres decreases the need for pinpoint accuracy demanded by single projectile weapons. The shape of the pellet (sphere) causes a rapid fall in velocity. For instance a #6 pellet having an initial velocity of 1295 fps at the muzzle will have a velocity of about 950 fps at 20 yards. Shotguns become ineffective in producing severe wounds at long ranges because of decreased velocity and decreased

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mass due to dispersion. At a range of ten yards approximately 95% of the pellets in #6 shot will be in a skin wound 9" in diameter when fired from a full length barrel; at twenty yards the wound diameter is doubled.\(^1\)

There is quite a variety of high velocity projectiles, however they can be grouped into two basic types. Jacketed or military type bullets generally produce a cylindrical wound tract, the size of which does not increase appreciably as the missile progresses through the tissue. The expanding bullet which is used for game hunting expands to several times the original caliber creating a very wide wound tract. Entry wounds of jacketed and expanding bullets tend to be about the same size but the exit wound and volume will vary. Jacketed bullets create an entry wound approximately 0.75cm in diameter; the exit wound is 2 cm in diameter and the wound volume is 23.5cc. An expanding missile produces a wound of 0.75cm in diameter and an exit wound of 12.5cm in diameter with a wound volume of 917cc.\(^2\) These figures show that an expanding missile has the capacity to produce a large amount of damage within a wound in which the bullet has been tumbling as it passes through the tissue, and may also create a larger volume of tissue damage if the missile travels straight through the tissue.

Damage can be created secondarily by a high velocity missile striking the tissues and fragmenting them, creating secondary missiles. It has been documented that these missiles can create shock waves which can reach 1000 lbs per square inch that pass through the tissues at the speed of sound. The bullet doesn't have to strike the tissue directly to cause damage. The higher the specific gravity of the tissue, the more damage that occurs from shock waves. Wounds of extreme severity can be produced in bone which has a specific gravity of 1.11. On the other end of the spectrum, the lungs with a very low specific gravity of 0.4-0.5 usually sustain minimal damage. Muscle and liver specific gravities fall in between bone and lung. Skin has a specific gravity of 1.09. Although it has a high specific gravity, skin contains elastic fibers which account for the variability of the wounds.\(^4\) The extent of the wound cannot be judged by the surrounding skin wound. Homogeneous solid tissues such as muscle bellies, liver and spleen are extensively damaged by high velocity missiles.

**TREATMENT**

All animals suspect of gunshot wounds should undergo a thorough physical examination. The practitioner may be drawn to the obvious only to have other important features overlooked. As in any emergency, upon admission the patient is checked for signs of shock and stabilized. If the animal is actively hemorrhaging, measures are taken to control it.

Radiographs may be requested by the owner for legal purposes. Radiographs help to determine the distribution of pellets or placement of the bullet, as in the case of shotgun wounds, some shot may lodge intra-articularly.

Wounds caused by low velocity missiles do not result in the degree of internal damage that is associated with high velocity missiles. Treatment is usually conservative, consisting of cleansing surrounding skin, application of a sterile pressure bandage, and immobilization by splinting. With through-and-through low velocity gunshot wounds, a pull through technique is used. This is done by soaking swabs in a mild antiseptic and then pulling them through the tract with the use of sterile forceps.\(^4\)

In wounds that contain lead shot, pellets are often found lodged in the subcutaneous tissues. The body treats the pellets as multiple foreign bodies by walling them off. Subcutaneous pellets seldom warrant further destruction of tissue to remove them unless a fistulous tract should develop.

Close range shotgun blasts produce much destruction of soft tissue. The paper packing and plastic cups used to separate the powder charge from the shot often penetrate deeply into the wound. These components are, unfortunately, not evident radiographically. A great deal of foreign material may be sucked into a wound by negative pressure. These types of wounds require removal of devitalized muscle, flushing, and lavage. The wound should not be sutured but should be packed, drained, and covered with a sterile dressing. Pulsating water jet lavage (Water Pik) with a large amount of saline has been successful in removing embedded fragments.

A more conservative approach to treating high velocity wounds is early wound débridement. Immediately after an injury, wounds frequently do not show a clear line of demarcation between viable and devitalized tissue.
Severely discolored tissue should be removed while saving as much skin as possible. There is a potential for infection and other complications when a conservative route is chosen. Abdominal wounds will require exploration because the most innocuous hole may be misleading. Exploration of the peritoneal cavity frequently reveals extensive damage to solid organs and multiple gastro-intestinal penetrations. Wounds involving the thorax should be carefully checked for signs of pneumothorax.

Some suggest a more radical approach by opening and inspecting the wound tract. This technique may require enlarging the wound or joining the entrance and exit wounds. Visualization in this approach determines whether debridement is necessary. If the wound appears free of foreign bodies or devitalization of tissue it may be sutured, leaving a drainage hole.

Devitalization of tissue found on extremities should be opened longitudinally to facilitate debridement and closure. In areas of flexion, wounds should be opened transversely for the same purpose. The wound should be left unsutured and bandaged for a period of time, followed by delayed primary closure in 4–10 days. If one chooses to close the wound, proper drainage should be established and the wound flushed daily with an anti-bacterial solution; systemic antibiotics are also suggested.

**CONCLUSION**

Gunshot wounds will always offer a unique challenge to the practitioner. There are many variables that are unknown upon presentation but by careful examination the practitioner can gain valuable information. The type of weapon used may be determined by the character of the wound and the presence of pellets or a single projectile. Once this is determined, the damage to the surrounding tissues can be ascertained. The location of the wound will dictate the extent of the diagnostic and therapeutic regimes. There is no one treatment regime in the management of gunshot wounds and each case should be treated as a separate entity.

**REFERENCES**