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# Laser in Dermatology

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**The laser is a tool that will augment the surgical techniques available to the veterinarian. When using the laser compared with traditional surgery there are multiple procedures that can be performed with much greater ease, and some procedures that previously could not be performed. Specialty and academic practices have used lasers for photodynamic therapy, lithotripsy of urinary calculi, and percutaneous disk ablation. This article will focus on the lasers use in dermatology. It is essential that the surgeon learn the basics of laser physics, how the laser interacts with tissue and the safety issues one needs to consider during its use. On deciding to use the laser the surgical techniques chosen should always be based on considering the advantages and disadvantages the laser has to offer. The use of biomedical lasers is a "cutting edge" technique now available to our veterinary field.**


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Multiple types of lasers are available but the way in which they store and release energy is similar. Lasers are usually named based on the types of atoms or molecules stored in their lasing medium. The medium may be solid crystal, liquid or gas. When energy is applied to the lasing medium, the atoms present are elevated to a higher energy state. On returning to their ground state, energy is liberated in the form of a photon. The photons then resonate in the laser chamber and stimulate other molecules or atoms. As the momentum escalates, mirrors in the chamber cause the photons to start traveling in parallel. This creates a highly concentrated, collimated beam of light. This beam of light will travel at a wavelength determined by the type of molecule in the lasing medium. As an example, in a $CO_2$ laser, the lasing media is $CO_2$ and the light beam produced travels with a wavelength of 10,600 nm versus an argon laser that produces a light beam with a 514 nm wavelength. Lasers are now produced with wavelengths extending from the ultraviolet range to infrared. This is important in understanding how the laser interacts with tissue, which is discussed below. See Table 1 for types of lasers and their wavelengths. Kenneth Bartels compares the light of a light bulb to plain noise and laser light as a pure note in music.[1] This is where the laser gets its power. The laser light is monochromatic (all of one wavelength). The laser light is coherent with the light waves traveling in phase (with the peaks and troughs aligned). Also the light waves are collimated meaning they travel in parallel. This is why the point of light from a laser pointer has the same size and intensity when applied to an object 2 feet, 10 feet, or 100 feet away from its source.

## How Laser Light Interacts With Tissue

When the laser comes into contact with tissue it may be absorbed by the tissue, transmitted through the tissue, scattered within the tissue, or reflected by the tissue (or instruments). Laser-tissue interactions have been categorized as photothermal, photochemical, or mechanical photodisruptive, depending on whether the absorbed laser energy is converted to thermal, chemical, or acoustic energy. Briefly the acoustic energy generated by a laser is a sudden pulse of energy which creates a shock wave in the tissue. An example of this in application is lithotripsy for calculi. Photochemical reactions occur when the laser light creates a chemical change in the tissue or photodynamic agent such as occurs with photodynamic therapy. The most common type of interaction we deal with is photothermal, when the light is absorbed by the tissue resulting in a rise in tissue temperature. This heat, depending on the dose applied to the tissue, may result in various stages of tissue damage. In the early stages the heat results in hyperthermia and cellular proteins are denatured resulting in permanent tissue damage. With additional heating coagulation of the tissue cells occur. This can be seen as mitochondrial swelling, eosinophilia and vacuolization. The next stage is vaporization. This is typically the goal of laser tissue interaction by the surgeon. The tissue has interacted by becoming a gas. This creates a plume of smoke that will be discussed under safety. The cells around the vaporized tissue will have absorbed some energy via diffusion of energy from the point of impact. This zone of thermal injury and tissue

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**Table 1** Types of lasers

| Types of Lasers | Wavelength (nm) |
|---|---|
| Excimer | 248 |
| Argon | 514 |
| Krypton | 532 |
| Dye and Diode | 577–780 |
| Helium Neon | 630 |
| Ruby | 694 |
| Near IR Diode | 810–980 |
| Nd:YAG | 1064 |
| Ho:YAG | 2100 |
| $CO_2$ | 10,600 |

necrosis varies with the technique used by the surgeon and by the use of pulsed laser beams will be reviewed shortly. Additional heating will result in carbonization that is a blackening of the tissue that changes the optical properties of the tissue and result in increased scatter, reflection and energy absorption. At this stage the surgeon is creating detrimental peripheral tissue damage beyond the cells absorbing the energy. Further lazing of the tissue results in stages the surgeon should avoid. This includes incandescence where tissue temperatures reach 350°C and sparks may be visualized and plasmolysis when tissue temperatures reach up to 2500°C and snaps and crackles can be heard. When the impact site reaches these temperatures there is a marked increase in the zone of thermal injury and this results in delayed healing, increased risk of infection or worse dehiscence of the wound.

Different tissue types will be preferentially heated depending on the cellular absorption coefficient and the wavelength of the light beam. The optical properties of tissue vary depending on their content of water, hemoglobin, protein, and melanin. Tissues have different energy absorption coefficients based on their water, hemoglobin, melanin, and protein contents. Water better absorbs longer wavelengths of energy such as that generated by the $CO_2$ laser. Water also tends to be in high levels in cutaneous tissues. Compare this to hemoglobin that absorbs shorter wavelengths preferentially. This is important knowledge when selecting which laser to use. For example for removing a skin lesion high in hemoglobin such as a port wine stain or removal of an angioma one would select an argon laser over a $CO_2$ laser. Lasers may be selected because their wavelength is not absorbed as well by water. Because of this trait the light beam will transmit deeper into the tissue. For example the $CO_2$ laser will only penetrate into tissue approximately 0.03 mm versus an Nd:Yag that will penetrate 1 to 3 mm. It is important for the surgeon to understand the depth of tissue penetration the choice of laser will cause as this will affect the peripheral tissue damage that can occur. Therefore, the best laser for a procedure depends on what type of tissue is being lased. Overall, for most procedures in the veterinary dermatology practice, the $CO_2$ laser is the laser of choice.

## Techniques When Using the Laser

It is not only important to choose the correct laser for a procedure based on how it interacts with the tissue. It is very important to understand how this energy is to be correctly applied to the tissue to minimize collateral tissue damage. The laser tip should be held perpendicular to the tissue. This will maximize the energy interaction with the tissue and minimize reflected beams. Energy is the amount of work done and the unit of energy is the Joule. Power is the rate of work and the unit of power is Watts (Joules/s). Therefore, if a 3 mm papule is to be vaporized it will require a certain amount of energy to vaporize the papule. The higher the power (wattage) the laser is set at the less time will be required to remove the lesion. It is also important to understand that this energy and power have a density depending on the size laser tip that is used to deliver the laser beam. The amount of tissue the laser is contacting is called the spot size. Decreasing the diameter of the laser tip by 50% will quadruple the power density (PD) if the laser is kept at the same power setting (Wattage) (Fig. 1). This is important to understand because if the energy it requires to vaporize a 3 mm papule is applied to 6 mm of tissue there will still be a deep margin of the papule remaining. If the correct amount of energy is applied to a 1 mm spot size in the center of the 3 mm papule the margins of the lesion will not be vaporized but deeper tissue not requiring removal will be vaporized.

Some lasers have a lens that allows for focused energy. This allows the user/surgeon to adjust the spot size not only based on the laser tip chosen but also based on the distance the tip is from the tissue (Fig. 2). The focused energy is used for incisions and to vaporize tissue. The defocused energy or larger spot sizes are used to coagulate tissue, which reduces hemorrhage, edema and can damage and kill remaining neoplastic or infectious cells in the tissue.

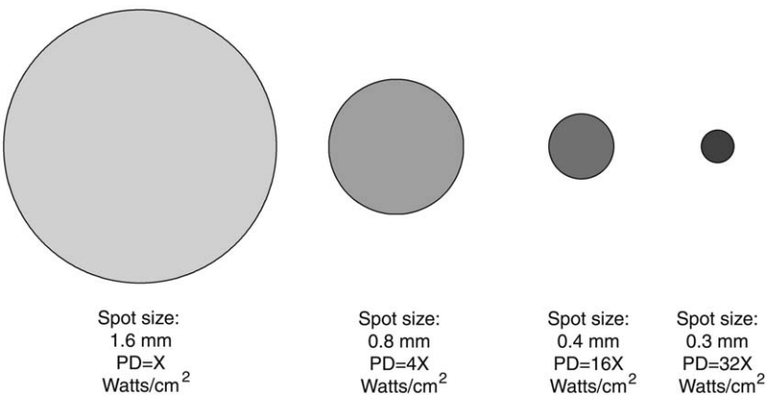


**Figure 1** Spot size and its effect on power density.

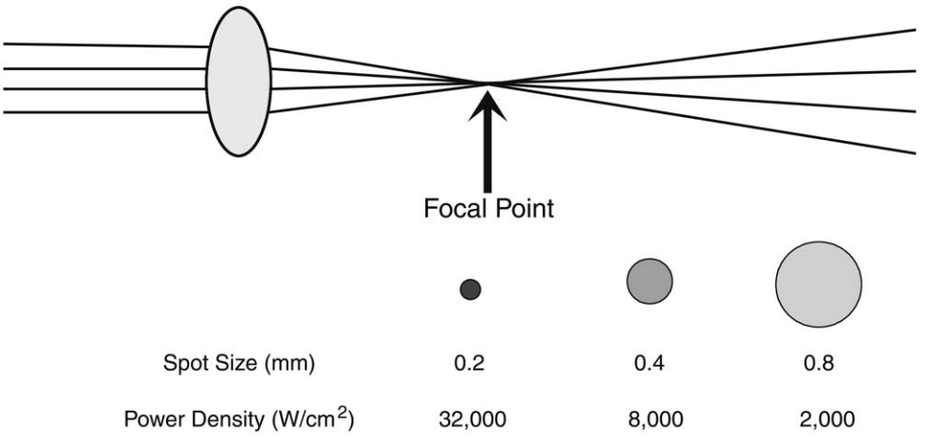


**Figure 2** Focal point and its effect on power density.

Another significant option to consider when using and purchasing a laser is the availability of a pulsed wave delivery option. What pulsing does is deliver the same power density to the tissue over the same amount to time, but instead of a continuous release of energy to the tissue, the beam is pulsed. There are beats of higher power density waves with fractions of seconds between the pulses. This allows something called thermal relaxation of the surrounding tissue to occur. Thermal relaxation is the time it takes for the tissue to cool. There are now options available called superpulsed and pulsed superpulsed. What pulsing allows is improved surgical precision and decreased collateral tissue damage. This could be compared with the improved results with cryotherapy when multiple short freeze thaw cycles are performed versus one continuous freeze cycle to a lesion. Again with multiple cycles in cryotherapy the result is more precise tissue freezing with less peripheral tissue damage.

## Laser Safety

A potential concern one may have with obtaining and using a laser is its safety. With proper training and conscientious adherence to safety protocols the risks are very manageable. Most of the lasers being used in veterinary clinics produce heat and vaporization of the tissue. This creates a plume of smoke. The plume can by irritating when inhaled and may contain viable organisms (bacterial or viral) as well as cells. There are laser safe surgical masks available and the plume must be removed with a smoke evacuator. The evacuators have a filter that should be changed based on hours of use. The surgical technician is responsible for logging the amount of time the evacuator is in use and changing the filter when appropriate.

As mentioned previously, there is heat generated by the laser, therefore surgical preparation should not include flammable products such as alcohol. Accidental fire can occur with flammable liquids, oxygen, paper drapes, or methane gasses. It is imperative to prevent endotracheal tube fires. There are laser-safe endotracheal tubes available or the practitioner can protect standard tubes with saline or sterile water soaked gauze when using lasers well absorbed by water. If surgery is being performed around the anal area, water soaked gauze should be placed in the anus. Similar to having a bucket of water near by when having a camping fire it is important to have a bowl of water or saline available at all times during a laser surgery.

When proper technique is not utilized the surgeon, staff, or patient may receive accidental skin burns. Remember the laser is a light energy much like a laser pointer used in lecturing. If the laser pointer is aimed at a hole in the projection screen the light will continue on to whatever is behind it. When cutting through tissue it is common to cut through one area more quickly then another. If the laser is passed over an area already incised, it continues on and will burn the tissue beyond. This may be the surgeon's finger or another tissue on the patient. Burns can be minimized by directing the beam at the surgical site, accurately using the foot pedal to activate the laser beam and using sterile water soaked gauze or tongue depressors as a backstop. The surgical technician should put the laser in standby mode when not in use to prevent accidental discharge and burns. Most lasers also have emergency shut off buttons that will prevent laser beams from being released.

The light from the laser can also be reflected and if reflected into the eye can create damage. Care should be taken not to aim the light at surgical instruments. There are laser instruments available with ebonized or burnished finishes, which decrease reflected light. Personnel in the operating room must all wear protective eyewear. The type of eyewear needed varies with the type of laser. Regular glasses or safety lenses are sufficient for the $CO_2$ laser. The patient's eyes should also be protected. Again sterile water soaked gauze may be placed over the eyes or there are special eye-cups and masks available.

For more information, the American National Standards Institute publishes a book of safety standards and regulations called *Safe Use of Lasers in Health Care Facilities.*

### Advantages and Disadvantages of Using the $CO_2$ Laser

There are many advantages to the $CO_2$ laser for dermatologic surgery. With a wavelength of 10,600 nm this laser is very well absorbed by water. It also does not penetrate deeply into the surrounding tissues. This feature allows more precision and less collateral tissue damage. The photothermal tissue interaction seals small blood vessels and provides a very dry surgical field even in highly vascular areas. Another benefit is less postoperative pain. The laser energy is painful at the time of surgery and general or local anesthesia must be used. However, postoperatively patients seem much less painful, and return to normal behavior more quickly. This can best be

**Figure 3** Multiple hemangiomas secondary to actinic dermatitis.

appreciated following a feline rhinectomy. The cats that have had a rhinectomy often are grooming and eating normally within 4 hours of their procedure when it has been performed with the laser versus traditional surgery. The laser does not crush or tear tissue; it vaporizes tissue and any microorganisms present, thereby sterilizing the field. The heat generated also seals lymphatics and there is decreased swelling. However, if poor technique is used and significant peripheral tissue damage because of thermal injury occurs, additional swelling will be noted.

Disadvantages to consider are very manageable but as mentioned above, safety and surgical technique protocols must be followed. Safety precautions must be followed to prevent staff and patients from accidental burns. The main difference initially frustrating to some surgeons is the fact that the $CO_2$ laser doesn't penetrate deeply; therefore, it takes longer to cut through tissue with a laser than with a scalpel. Remember this is also an advantage for precision and control of hemorrhage. However, because it takes longer to cut through the tissue this can lead the novice user into the improper technique of continuing to apply the laser beam to the same site without moving the hand piece in an attempt to cut through the tissue. This results in super heating of the tissue and increased peripheral tissue damage. With training the surgeon becomes much better with a technique of stroking the laser beam over the tissue to make an incision, thereby decreasing peripheral tissue damage and allowing thermal relaxation to occur.

**Figure 4** Feline ceruminous cystomatosis.

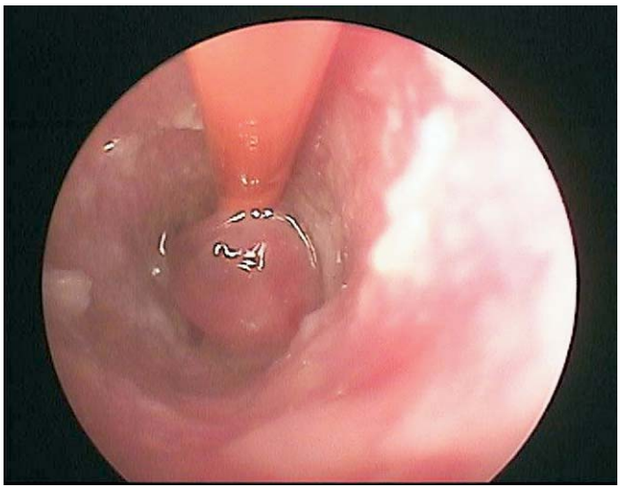

**Figure 5** Mass in the vertical ear canal. (Color version of figure is available online.)

## Clinical Use of the Laser in Dermatology

The $CO_2$ laser has been very helpful in patients that have multiple epidermal lesions to be removed and especially in cases where closure of the lesion may not be possible. Depending on size and depth, lesions, once removed, heal very well by secondary intention; often as quickly as lesions closed with primary closure. Examples of more common lesions would include multiple sebaceous adenomas, keratoacanthomas, and hemangiomas (Fig. 3). There are multiple breeds in which multiple sebaceous adenomas can affect the quality of life because of pruritus and secondary infections. The removal of these lesions can significantly decrease the requirement for medical therapy to control infections and pruritus.

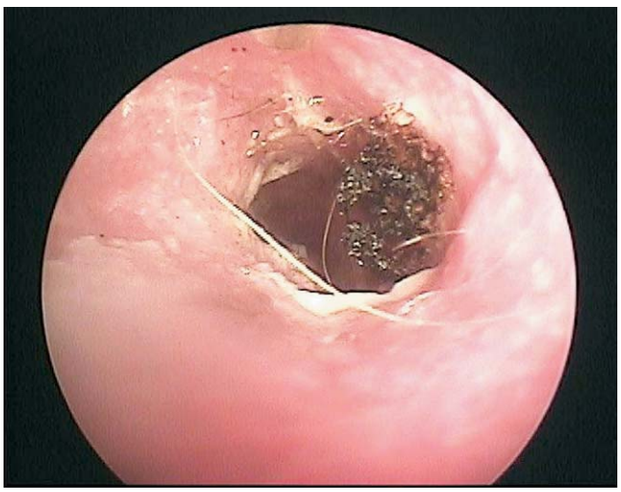

**Figure 6** Open ear canal with eschar at the base of the mass removal. (Color version of figure is available online.)

**Figure 7** Proliferative tissue from chronic otitis. (Color version of figure is available online.)

The laser is also very helpful in removing epidermal lesions difficult to close with primary closure, and in some cases laser is the only therapy with good success. Feline ceruminous cystomatosis is an example (Fig. 4). This is an entity in which multiple fluid filled ceruminous cysts form initially on the tragal folds of the pinna. If left untreated, the cysts extend down into the canal, occlude the canal, and secondary otitis externa and/or media develops. The cystic tissue is very thin and often adjacent to the pinnal cartledge. This makes removal of the entire cyst difficult with traditional surgery and without the removal of the entire cyst recurrence is likely. Masses within the ear canal may also be removed with the $CO_2$ laser though a video otoscope preventing more invasive surgery that would entail additional risk and pain to the patient. Figures 5 and 6 depict a mass in the vertical canal of a dog's ear before removal and then after having the base ablated with a $CO_2$ laser (Figs. 5 and 6). Another example of a cutaneous neoplasia typically at sites difficult to remove is a cutaneous angioma.[2] In veterinary patients, because of the progressive proliferative nature of this condition, previous recommendations included wide surgical excision or amputation. If the lesions occurred in a location where this was not possible

**Figure 8** Feline nasal squamous cell carcinoma. (Color version of figure is available online.)

**Figure 9** Postlaser rhinectomy. (Color version of figure is available online.)

(such as the face) the pets were euthanized. Laser therapy has been reported to be a successful alternative in these cases.[1]

Infected tissue can be vaporized or removed using the laser. Surgical technique is very important so that the healthy tissue to remain is not contaminated with infected cells. The types of infections where this is important include papiloma virus, herpes dermatitis, and sarcoids. The utilization of the laser with proper surgical technique has resulted in decreased recurrence rates post therapy. Another type of infected tissue includes chronic proliferative infected tissue (Fig. 7). This is most commonly seen in cases of chronic otitis in certain breeds such as the American Cocker Spaniel. If this problem is identified before calcification of the canal occurs, the duration of medical therapy may be shortened or total ear canal ablation may be avoided. Once the deep folded cauliflower like tissue is removed medical therapy is much more effective.

Highly vascular areas are more easily handled using the laser. One of the more common procedures it has been recommended for is feline rhinectomy and/or pinnectomy. In the hands of an experienced laser surgeon, this procedure takes about 15 minutes, with more hemorrhage occurring from the sutures then the tissue removal (Figs. 8 and 9). Masses may be removed or biopsied from the oral cavity. Remember care must be taken to protect the endotracheal tube when oxygen is being administered for maintenance anesthesia.

In summary, the laser is a new tool available to the veterinarian allowing a wider variety of surgical procedures to be performed. To do this properly without injury to the patient, clinician or staff, proper training classes, and workshops should be attended. These workshops will demonstrate, in lectures the physics mentioned above and also, with hands on techniques, how variable power densities, spot sizes and tissue types will affect which laser is chosen and how the laser can be utilized. There is a Veterinary Laser Association one can join to stay up to date on upcoming classes and procedures.

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