
## Abstract

Use of surgical lasers in veterinary dermatology has increased. Carbon dioxide ($CO_2$) laser is ideal for either ablation or excision of lesions caused by a variety of conditions. Achieving optimal results requires knowing how to manipulate the settings. Although $CO_2$ lasers may at first seem intimidating, they are very user friendly.

DERMATOLOGY

# Laser Therapy in Small Animal Dermatology

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The term "laser" originated as an anacronym for *light amplification by stimulated emission of radiation*. In veterinary medicine, lasers are typically classified as therapeutic or surgical. Therapeutic lasers consist of cold or red lasers used for wound healing and anti-inflammatory effects. Surgical lasers used in veterinary medicine are diode lasers and carbon dioxide ($CO_2$) lasers. Diode lasers have a solid crystal as the lasing medium and deliver infrared light at significantly lower wavelengths than the $CO_2$ laser, for which gas is the lasing medium.[1] Some clinicians have replaced the scalpel blade with the surgical laser for many applications. Benefits of using surgical lasers rather than scalpel blades include the ability to seal blood vessels, nerve endings, and lymphatics; to sterilize the tissue; and to make precise incisions.[2]

## TYPES OF SURGICAL LASER USED IN VETERINARY MEDICINE

### Diode Lasers

Diode lasers have a crystal that is placed in contact with the skin to incise through the tissue. Unlike $CO_2$ lasers, diode lasers work in a liquid interface, which enables their use in saline, blood, or urine. Diode lasers are flexible and can be passed through channels and ports, making them easily used in conjunction with endoscopy equipment. The major downside of diode lasers is that they produce about 10 to 20 times more collateral tissue damage at the incision than $CO_2$ lasers, thereby increasing the risk for wound dehiscence.[1] Thus, use of diode lasers in veterinary dermatology is limited.

### Take-Home Points

- Surgical lasers can seal blood vessels, nerve endings, and lymphatics; can sterilize tissue; and can still be used to make precise incisions.
- Surgical laser types are diode and carbon dioxide ($CO_2$); the preferred surgical laser for veterinary dermatology is $CO_2$.
- Adjusting the power and mode of a $CO_2$ laser is necessary for adapting between ablating and excising a lesion.
- Recommended applications for those just starting to use $CO_2$ lasers are cutaneous (e.g., sebaceous, round cell) tumors.


**FIGURE 1.** The varying sizes of removable tips used with a $CO_2$ laser.

## $CO_2$ Lasers

The infrared light from the $CO_2$ laser is absorbed by water in the skin and, when used optimally, vaporizes the intended tissue only. A variety of tips can be used with the $CO_2$ laser (**FIGURE 1**). The smaller tips (e.g., 0.25 mm) are ideal for incising into skin; the larger tips (e.g., 0.8 to 1.4 mm) are ideal for dissecting or ablating the tissue. Clinicians should be familiar with how to use adjustable settings such as power (in watts) and mode (i.e., single pulse, repeat pulse, continuous wave, superpulse) (**FIGURE 2**). The surrounding peripheral tissue damage is significantly less with the use of a $CO_2$ laser than a diode laser. For these reasons, the $CO_2$ laser is the preferred surgical laser for veterinary dermatology. This article focuses on the use of the $CO_2$ laser.

## SAFETY

Not following safety protocols poses risks for both the personnel using the $CO_2$ laser and the patient. Personnel in the room should wear masks to minimize inhalation of the fumes that escape from the evacuator system and eye protection to prevent damage if the laser is reflected or aimed inadvertently into the eyes.

To prevent inadvertent lasing of other tissue or the operator, saline-soaked gauze can be used as a protective barrier around the target tissue being cut. Alcohol should not be used on the patient because it is flammable. The intubation tube and connectors must be covered with saline-soaked gauze to prevent lasing through the tube and igniting oxygen within the endotracheal tube.

## TECHNIQUES

To determine which technique to use, clinicians need to first know whether they are planning to submit tissue for histopathology. In addition, clinicians need to

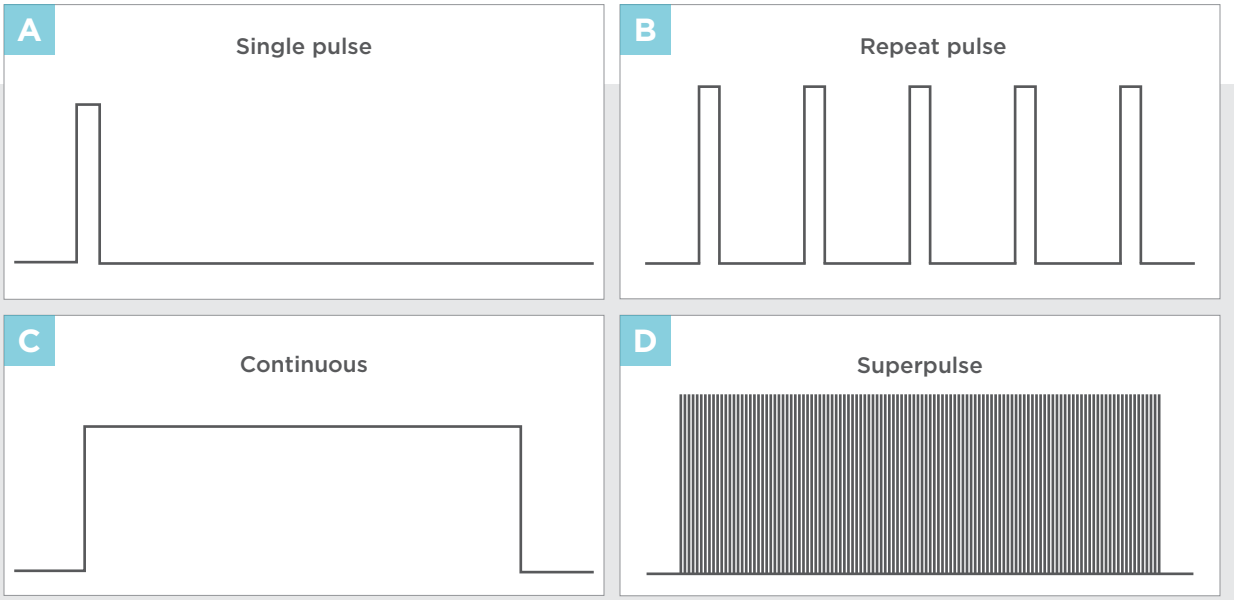


**FIGURE 2.** $CO_2$ laser modes. **(A)** Single-pulse mode delivers a single pulse as shown by the individual peak. **(B)** Repeat-pulse mode delivers repeated peaks at set increments with set breaks in between. **(C)** Continuous mode delivers constant exposure of the tissue to light, shown as a single plateau. **(D)** Superpulse mode delivers higher peaks of light, but to prevent collateral thermal tissue damage, it provides short breaks between peaks to allow the tissue to cool in between exposure to the $CO_2$.

know how they plan to manage the tissue defect after the procedure: healing by secondary intention or suturing it closed to heal by primary intention.

## Ablation

Ablation is accomplished by using the laser to vaporize the tissue, similar to using a pencil eraser. Using this technique leaves no diagnostic sample left to submit for histopathology. Ablation is also performed when the operator plans to allow the defect to heal by second intention or is less concerned about collateral thermal damage to the surrounding tissue.

For tissue ablation, the $CO_2$ laser should be used in the continuous mode. Char, the carbonization of nonfluid cellular components (blackening of the tissue), will develop on the tissue as you ablate it. To prevent increased temperature of the tissue causing excessive peripheral tissue damage, char should be removed with saline-soaked gauze when it forms.[3]

## Excision

The laser can be used to excise around the tissue, similar to a scalpel blade. Excision is the approach of choice when a tissue sample is needed to submit for histopathology. During surgical planning, fine-needle aspiration should be performed to determine if the lesion is neoplastic and thus if margins are relevant. When tissue is excised, the defect is usually sutured and allowed to heal by primary intention. Excision should be performed with the $CO_2$ laser in superpulse mode, which compared with continuous mode minimizes the amount of collateral thermal damage.

# CLINICAL USE

Although using any new technology or equipment can be intimidating at first, $CO_2$ lasers are very user friendly. Observing the interaction of the light from the $CO_2$ laser and the tissue enables the user to adjust their approach in real time. If the incision through the tissue is too shallow, then you need to either increase the power or slow down your hand speed across the incision. If the incision is too deep, then you need to


**FIGURE 3.** Sebaceous adenoma **(A)** before and **(B)** after $CO_2$ laser ablation. When excess tissue is minimal, such as on the tail **(C)**, a combination of excision and ablation can be performed **(D)**.

speed up your hand speed or decrease the power. If there is a moderate amount of char at the laser site, then excessive peripheral tissue damage is being caused, which is common when the speed is too slow and the power is low. For optimal results, decrease peripheral damage by increasing the power setting and moving across the tissue faster to limit the amount of time the laser is focused on specific tissue. In addition, the laser must be set at the appropriate mode. For skin incisions, using the superpulse mode is ideal because that mode will produce intervals of high power and short break times to cool the tissue and limit the amount of peripheral tissue damage. When tissue is ablated, it is common to keep the laser in continuous mode, although peripheral tissue damage is a sequela.

## $CO_2$ LASER APPLICATIONS, BY LEVEL OF DIFFICULTY

### Low Difficulty

For those who are new to using $CO_2$ lasers, starting with cutaneous masses is recommended. A huge benefit of working with cutaneous masses is that the subcutaneous fat acts as a barrier, preventing damage to more delicate areas of the body after excising or ablating through the skin.

#### Sebaceous Tumors and Sebaceous Hyperplasia

Sebaceous adenomas and sebaceous hyperplasia are very common in older dogs. Although benign, they can be repeatedly traumatized by the patient or by a groomer, which necessitates intervention. Local anesthetics (e.g., subcutaneous lidocaine) can be used for single lesions in calm dogs; however, when several lesions are to be removed, sedation or general anesthesia is commonly used. $CO_2$ laser ablation of sebaceous adenomas and sebaceous hyperplasia is a very common procedure, and the success rate is high if all abnormal tissue is ablated (**FIGURE 3**). If tissue is needed for histopathology, the tissue can also be excised. A combination of excision of the tissue followed by ablation of any residual microscopic neoplastic cells has been described for patients for which masses cannot be removed in their entirety and primary closure is not an option (e.g., regions that often lack adequate tissue for primary closure, such as the tail) (**FIGURE 3**).[4] Sebaceous epitheliomas and sebaceous carcinomas can also be treated similarly with a $CO_2$ laser, but they are rare and not treated as often.


**FIGURE 4. (A)** Round cell tumors can be excised for histopathology when **(B)** there is plenty of excess tissue surrounding the mass to allow adequate margins and **(C)** suturing to close by primary intention.

### Round Cell Tumors

The advantages of using $CO_2$ laser rather than a scalpel blade apply to round cell tumors. However, even optimal use of the $CO_2$ laser creates some minimal peripheral tissue damage, which can make it difficult for the pathologist to determine if the margins are clean or dirty. Therefore, when neoplastic tissue is being excised for histopathology, plan to excise at least an extra 0.5 mm beyond the normal margin to allow visualization of the border of the tumor (**FIGURE 4**). To enable defect closure and healing by primary intention, the optimal mode is superpulse. One study showed that combined excision and ablation of the margins may be beneficial with round cell tumors that are localized on limbs, eyelids, the nose, lips, and ears.[4]

## Moderate Difficulty

The following clinical applications of $CO_2$ laser use are considered to be of moderate difficulty due to thinner skin in some locations and the location on the body.


**FIGURE 5.** Perianal adenoma. **(A)** Ulcerated and bleeding before $CO_2$ ablation and **(B)** after ablation.

### Perianal Adenomas or Hyperplasia

$CO_2$ laser is an ideal surgical tool for use in the perianal region. Hepatoid glands are modified sebaceous glands in the perianal region. Hepatoid adenomas and hyperplasia are commonly observed in older dogs and may ulcerate and cause excessive bleeding (**FIGURE 5**).

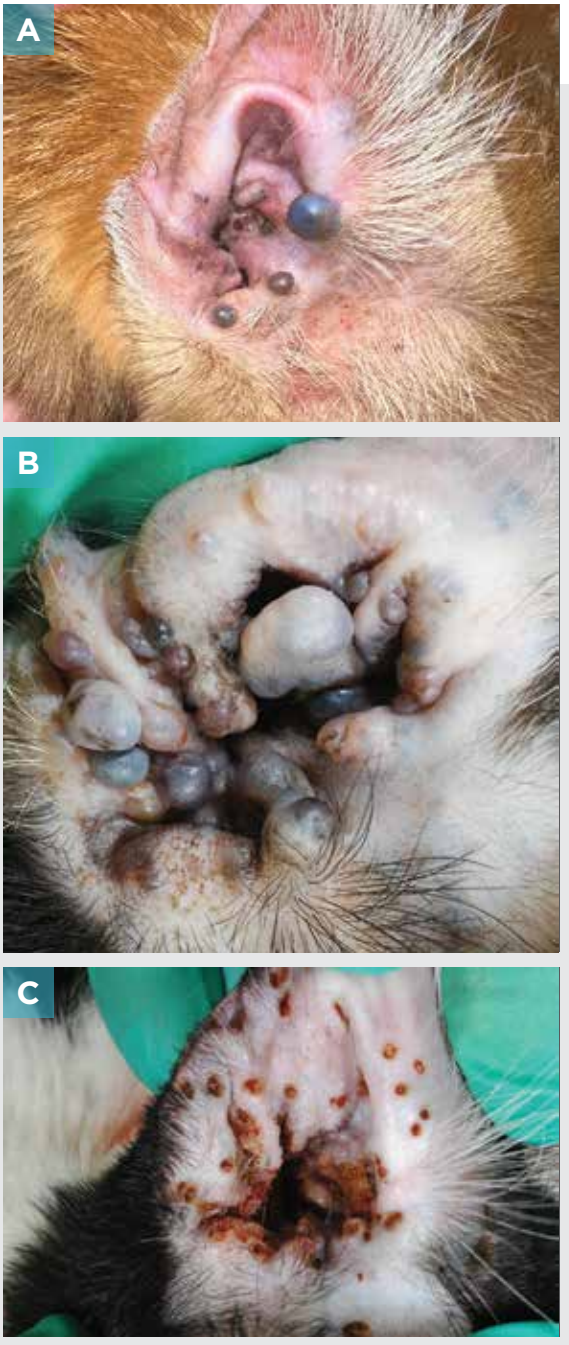


**FIGURE 6.** Ceruminous cystomatosis. Pictured as **(A)** only a few cysts at the entrance of the ear canal and **(B)** much more extensive and numerous cysts at the entrance and within the ear canal before $CO_2$ laser ablation. **(C)** After ablation.

The $CO_2$ laser is a good option for excising these masses because of their tendency for increased vascularization. The high concentration of nerves in the perianal region makes fecal incontinence a huge risk for any surgery. Precise cutting or ablation with the $CO_2$ laser is ideal for preventing further damage to the surrounding tissue. Packing the rectum with saline-soaked gauze and performing a purse-string suture are recommended safety precautions to prevent fecal contamination or methane gas leakage.[5]

## Ceruminous Cystomatosis

Ceruminous glands are modified apocrine glands that can become cystic. They are a classic blue to purple color and will produce a brownish oil when ruptured. These masses are most often found on the pinnae of cats and vary from a few to numerous (**FIGURE 6**). Ceruminous cystomatosis can occasionally be present in the vertical and horizontal ear canal and predispose the patient to recurrent or persistent otitis externa.

$CO_2$ laser ablation of ceruminous cysts is the treatment of choice over pinnectomy or total ear canal ablation, and the reported success rate is very high. Although new cysts unfortunately often form in the same area or in another location on the ear, they are often slow growing. Care should be taken when ablating ceruminous cysts on the pinna. The skin in this area is thin and ablation should be stopped as soon as cartilage is visualized to prevent thermal damage and necrosis.[6]

## Meibomian Gland Adenoma

Meibomian gland adenomas are the most common tumor affecting the eyelids in older dogs. Treatment options have historically included surgical excision of the adenoma and surrounding eyelid or even cryotherapy. $CO_2$ laser ablation of meibomian gland adenomas has been very successful (**FIGURE 7**). However, care must be taken to avoid excessive damage to the tissue and subsequent disfigurement because the eyelid is very thin, which is why use of lower power is recommended for this application.[7] In addition, protection of the cornea, whether with saline-soaked gauze or an eye shield similar to a contact lens (corneal shield), is necessary.

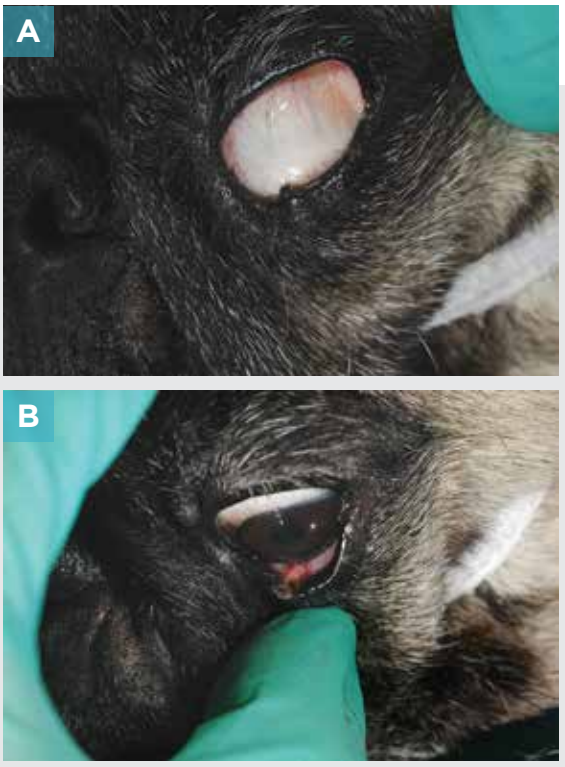


**FIGURE 7.** Meibomian gland adenoma on the lower eyelid. **(A)** Rubbing on the cornea before $CO_2$ laser ablation. **(B)** After ablation.

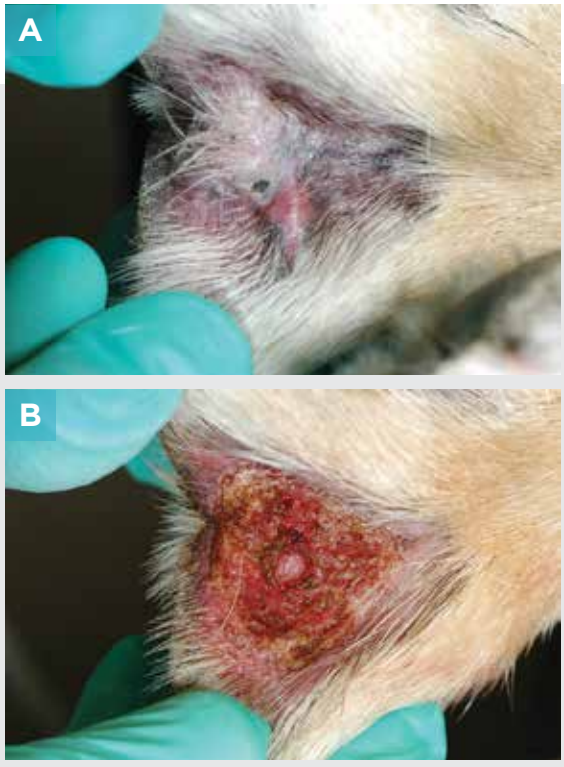


**FIGURE 8.** Top-down interdigital furunculosis caused by trauma. **(A)** Before $CO_2$ laser ablation. **(B)** After ablation.

## Interdigital Furunculosis

Two types of interdigital furunculosis (interdigital cysts) affect dogs. The top-down variety results from trauma to the top of the paw (**FIGURE 8**). Most dogs with the top-down variety are licking the paws, usually because of suspected allergic dermatitis. The bottom-up variety results from plugged hair follicles that are distended on the underside of the paw, producing a redundant false pad (pseudopad) (**FIGURE 9**). Over time, the client will note swelling on the top of the paw and draining tracts. Although the underlying issue needs to be addressed to prevent formation of new lesions, the excessive tissue needs to be removed.

Previously, it was recommended to perform a fusion podoplasty. A newer technique involves using a $CO_2$ laser to ablate the interdigital furunculosis down to normal-appearing tissue.[8] With either the top-down or the bottom-up variety, ablation of the furunculosis is commonly performed and is the technique described in the literature.[8] The author has found more success by excising around the nodule/mass effect with the $CO_2$ laser in the bottom-up variety when the lesions are large. Dissection of the abnormal tissue will leave a normal tissue bed to heal by second intention with shorter healing times than the ablation technique.

The difficulty of these procedures varies from moderate to hard, depending on the number of interdigital furuncles present and the number of paws affected. Some larger vessels in the interdigital region of the paws are too large to seal with the $CO_2$ laser, and some operators will use a tourniquet during the procedure to decrease bleeding should one of the large vessels inadvertently be affected.

## Papillomas

Papillomas can appear anywhere on the skin, including the oral mucosa. Papillomas can be excised with the $CO_2$ laser at the base or with complete excision of surrounding tissue to provide margins. For patients with numerous papillomas, $CO_2$ laser excision at the base is a quick and efficient way to remove them. Oral papillomatosis is an ideal clinical situation for using the $CO_2$ laser, usually due to the large number of papillomas (**FIGURE 10**). Paw pad papillomas may either be highly keratinized and proliferative structures

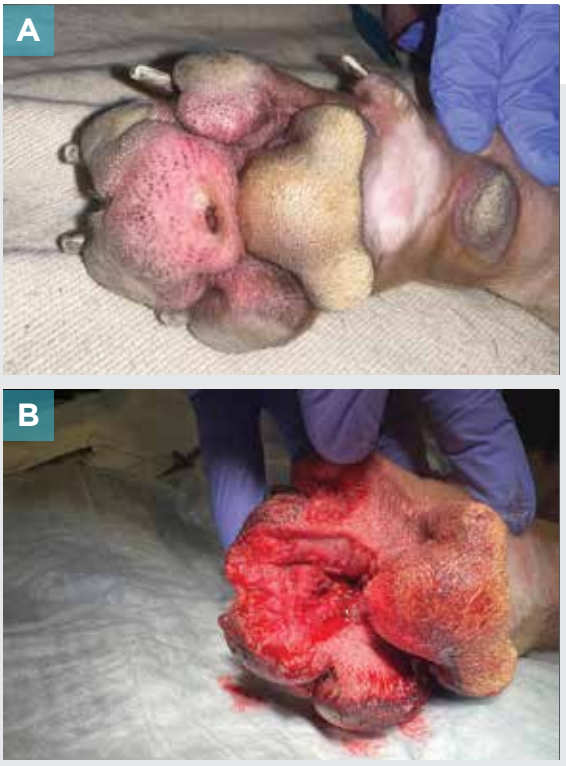


**FIGURE 9.** Bottom-up interdigital furunculosis. **(A)** Large pseudopad on digit 2 and between digits 3 and 4 before $CO_2$ laser ablation. **(B)** After ablation.

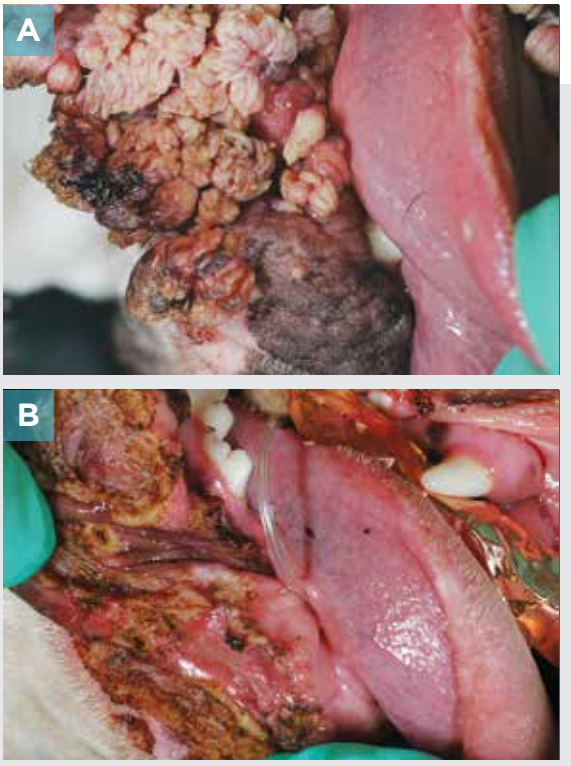


**FIGURE 10.** Numerous oral papillomas throughout the oral cavity in a dog. **(A)** Before $CO_2$ laser ablation. **(B)** After ablation.

or large broad-based lesions (**FIGURE 11**). $CO_2$ laser ablation of broad-based paw pad papillomas has been successful, but several procedures may be necessary, depending on severity.

## High Difficulty

The following clinical applications are considered of higher difficulty due to the amount of time the procedure could take, the number of procedures required to make the area normal, or the possible need for specialized equipment.

### Chronic Proliferative and Obstructive Otitis Externa

This condition involves chronic otitis externa with significant proliferative tissue completely obstructing the entrance of the external ear canal. Affected ears look like someone put a piece of cauliflower in the entrance of the ear (**FIGURE 12**). In these patients, the vertical ear canal is usually normal. Surgical ablation or excision of the proliferative tissue have been described as a successful treatment.[2] However, if the vertical ear canal is affected, $CO_2$ laser ablation is not recommended due to the major concern that the tissues could heal together and form a stricture. The high difficulty level results from the risk for stricture and need to choose appropriate cases.

### Ear Tumors

Ear masses cause recurrent ear infections in dogs and cats. Masses can be removed with traction and submitted for histopathology for a diagnosis. If incompletely removed, the tumor will likely recur and


**FIGURE 11.** Paw pad papillomas as proliferative and keratinized papillomas on the paws with either a few (**A**, before; **B**, after) or numerous large (**C**, before; **D**, after) lesions.

potentially become more invasive, which is especially concerning with ceruminous gland adenocarcinomas and why total ear canal ablations are usually recommended. A recent study has shown relatively high success when ceruminous gland adenocarcinomas are treated with debulking and then $CO_2$ laser ablation of the base of the tumor to remove microscopic neoplastic cells (**FIGURE 13**).[9] This technique is applied to other ear masses as long as they are not invasive and penetrating through the cartilage of the ear canal. The procedure is considered to be of high difficulty because it must be performed through the operating channel of a video otoscope if in the vertical or horizontal ear canal. In addition, a special longer metal tip is needed to operate through the video otoscope.

### Chronic Interdigital Furunculosis

Chronic interdigital furunculosis in which the redundant tissue affects most of the palmar or plantar aspect of the paws or when more than 2 paws are affected would classify it as a higher-difficulty procedure. The procedure would be the same as that for patients with single interdigital furunculosis. The concern is the amount of time the procedure takes to treat multiple paws and having to manage large open wounds during healing. In addition, patients will potentially require multiple procedures when more than 2 paws are affected.

## SUMMARY

Surgical lasers have changed how surgery for veterinary dermatology cases is performed. The $CO_2$ laser is the ideal surgical laser because it creates much less

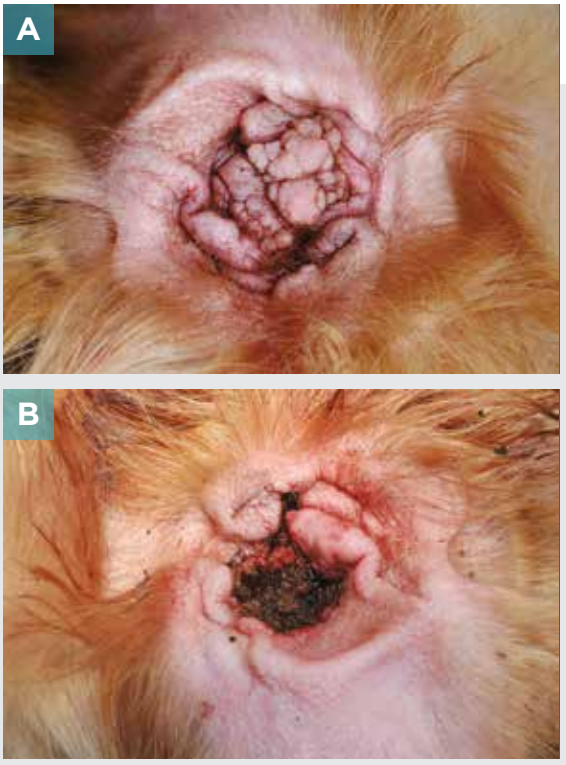


**FIGURE 12.** Chronic and proliferative otitis externa. **(A)** Complete occlusion of the entrance of the ear canal before $CO_2$ laser treatment. **(B)** After tissue excision followed by ablation to remove excessive tissue.

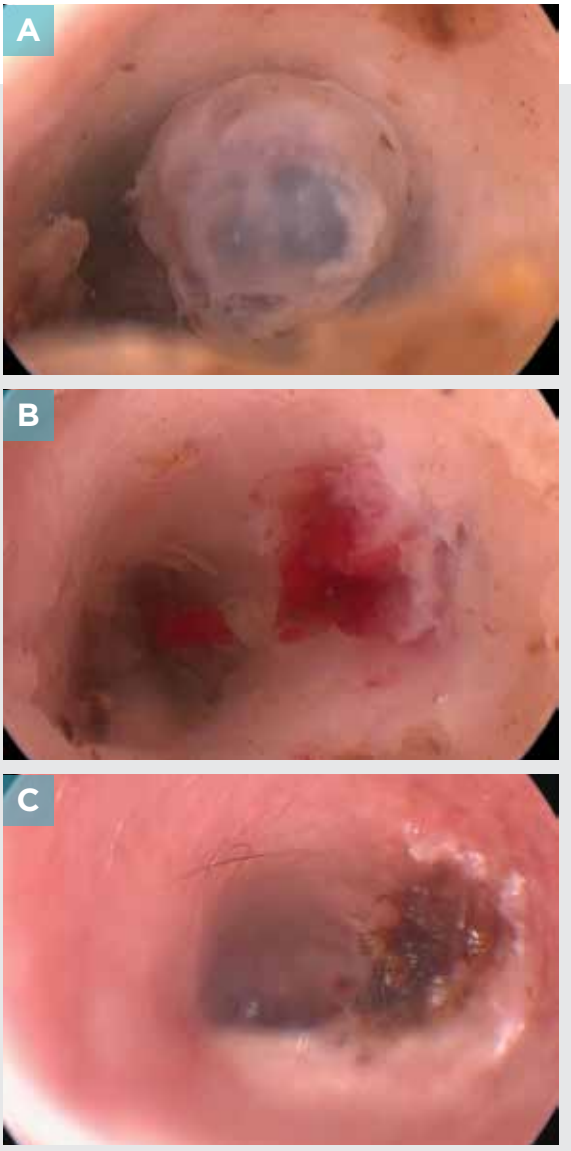


**FIGURE 13.** Ceruminous gland tumor. **(A)** Appearing as a solitary mass within the ear canal. **(B)** After removal by traction. **(C)** Redundant tissue that can be ablated with a $CO_2$ laser to prevent recurrence.

peripheral tissue damage than the diode laser. In addition to the clinical conditions discussed above, there are many other applications in which a $CO_2$ laser can be used in small animal dermatology. TVP

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Dr. Pieper is a board-certified veterinary dermatologist working at Iowa State University as an assistant professor. He has published numerous journal articles and book chapters and presented a variety of research abstracts at conferences. He has a strong interest in $CO_2$ lasers, has almost 15 years of experience with $CO_2$ lasers, and has lectured at the Veterinary Laser Surgery Symposium on clinical use of $CO_2$ lasers in veterinary dermatology. One of his recent publications describes a novel treatment for ceruminous adenocarcinomas. Other research and clinical areas of interest include antimicrobial resistance, dermatophytosis, and dermoscopy.