Acclaimed CO_2 Laser Authority Compares Delivery Systems

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Dr. Godbold has been involved in veterinary laser technology since 1999. In addition to teaching, he has worked with over 10 laser equipment manufacturers in the design, development and testing of laser devices, device software, and accessories.

Equally important has been Dr. Godbold's role in the development of techniques and procedures using the CO_2 laser. He has published in the *Journal of the AVMA*, *Laserpoints*, and the *Newsletter of the Veterinary Laser Surgical Society*. In 2002 he published the widely acclaimed CD Atlas of CO_2 Laser Surgery Procedures. This publication, updated each year since, has been distributed across the world to over 7,000 colleagues. Excerpts from Dr. Godbold's CD Atlas are incorporated into the software of several manufacturers' laser devices.

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THROUGH THE HANDPIECE

A FOCUSED LOOK AT CO_2 LASER DELIVERY SYSTEMS

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Key points in Dr. Godbold's article –

- Hollow waveguide (HWG) lasers are new technology.
- Articulated arm (AA) lasers are old technology.
- HWG lasers are lighter, thinner, more flexible and more ergonomic.
- AA lasers are heavier, thicker, bulkier, and less ergonomic.
- HWG lasers have a shorter "tip to tissue" distance and are more precise.
- HWG lasers offer multiple spot sizes. AA lasers do not.
- HWG lasers offer greater surgeon control of beam configuration.
- HWG lasers give the surgeon the benefit of rapid defocusing.
- HWG lasers calibrate externally where the laser beam exits the laser.
- AA lasers calibrate internally (if at all) before the laser beam exits the laser.
- The claim that HWG "fibers" require frequent replacement is a myth.
- The claim that HWG focusing tips are expensive disposables is a myth.

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Introduction

For over a decade veterinary surgery has been undergoing a transformation with CO_2 lasers becoming an important part of the well-equipped surgical suite. The adaptation of CO_2 lasers to veterinary surgery has been an unprecedented, practitioner-developed technology, with a rapid expansion of knowledge and techniques, and an equally unprecedented support of practitioner education from laser manufacturers.

The rapid acceptance of CO_2 laser surgery by practitioners, and the resultant success of commercial entities bringing the technology to veterinary surgery, has attracted entry into the market of a spectrum of equipment vendors. Each claims their devices best meet the needs of veterinary surgeons.

With multiple vendors and equipment types vying for market share, marketing strategies have resulted in increasingly confusing claims. Practitioners considering CO_2 laser technology are often faced with contradictory information about available equipment. Who to believe? What to believe?

This article presents an objective analysis of the CO_2 laser equipment currently available. The goal is to give prospective purchasers relevant information to help them make knowledgeable decisions prior to making a purchase.

The Author's Background and Qualifications

When lecturing about laser technology, I frequently say to colleagues "What I am is one of you, and where I come from is very average small animal practice USA". That statement is true. While having been very involved in laser technology since 1999, I am a solo practitioner in a general suburban small animal practice, albeit one with a special interest in laser technologies. Since 2000 I have used eight different CO_2 and diode lasers in my practice.

Starting with my first CO_2 laser surgery in 2000, the technology has been used in every surgery I have performed. My hands-on experience in surgery, as well as the shared experience of thousands of colleagues I have spent time with in educational events has given me a unique insight into how effective various types of laser equipment are for those who use them.

Further, the opportunity I've had to work with many different laser equipment manufacturers in the design, development, and testing of laser devices and accessories has contributed to a sound knowledge of the technology.

It should be noted I have been a frequent continuing education speaker since 2001 and have received honoraria and expense reimbursement when participating in industry sponsored events. However, as an industry consultant, I have never accepted payment from any equipment manufacturer or vendor. And, I have never accepted "referral fees" nor other compensation related to the sales of equipment. I hold no contractual agreement with any commercial entity.

Thus, this article contains the same information the reader would get in a private conversation with me – the perspective of an experienced practitioner, untainted by economic interest, freely shared with a colleague.

A Look Back

Although articulated arm (AA) CO_2 laser delivery devices were first adapted for surgical use in the 1970's, the first CO_2 laser to widely penetrate veterinary surgery was the hollow waveguide (HWG) laser developed in 1994.

Originally introduced to veterinary surgeons as a "tool looking for a use," the HWG laser found rapid acceptance. Veterinary surgeons quickly appreciated the diversity of procedures that could be performed with greater precision, less hemorrhage, and less post-op swelling and pain. With strong industry support of practitioner education and practitioner development of the technology, HWG CO_2 laser surgery became "the" technology of the profession in the early 2000's.

Market success attracts competition. Since the HWG delivery system was new and tightly patented, the only way other manufacturers and vendors could enter the veterinary market was to re-package and re-cycle older AA devices. Although a myriad of manufacturers and vendors are currently in the market with devices using the older AA technology, the HWG delivery system remains entrenched with the largest customer base of any surgical laser ever sold.

The Two Different Delivery Systems

1. Articulated Arm Delivery System -

Available in a large number of shapes, sizes, and models, the AA delivery systems are all the same basic technology originally developed in the 1970-1980's. All utilize glass laser generation tubes cooled by flowing liquid. Because of the inefficiency of glass laser tubes, these devices require very high voltage power supplies (>10,000 volts).

The laser beam is delivered from the laser to the tissue through a thick, bulky, elbowed, mirrored articulated arm. The beam exits the arm through an equally bulky autoclavable focusing lens handpiece. The lens in the handpiece (focal length 50 - 100 mm) focuses the laser beam to a fixed 0.2 - 0.25 mm spot some distance (usually 2 - 3 cm) from the end of the handpiece.

Since the operator must hold the handpiece away from the tissue for the beam to focus, these devices require an aiming beam that produces a 2 - 3 mm visible spot.

2. Hollow Wave Guide Delivery System -

The 1994 HWG delivery system was such a substantial jump forward in technology, and was so stable and adaptable, it remained unchanged for over a decade. A second generation of the devices was released in 2006.

HWG lasers utilize a more efficient metal laser tube which requires a low voltage power supply (32 volts). The original passive air flow cooling design, while effective, was updated to active air flow cooling with the 2006 release.

The laser beam is delivered through a thin flexible hollow tube with a reflective interior coating (commonly called a "fiber", more accurately called a "hollow waveguide"). The laser beam exits through a thin, autoclavable handpiece and is focused by interchangeable, autoclavable focusing tips that focus the beam to 0.2, 0.25, 0.3, 0.4, 0.8, 1.4, or 0.4 x 3 mm spots.

The focusing tips have a focal length of 0.75 – 3 mm which means the handpiece is held very close to the tissue. No aiming beam is required. A gentle flow of air is pumped through the HWG and exits the focusing tip, preventing contamination of the tip by tissue fluid or debris.

Comparing and Contrasting the Delivery Systems

CO_2 laser use has become widely accepted in veterinary surgery because of the advantages it offers. The advantages of reduced hemorrhage, swelling and pain are well known. Equally important are the advantages of increased precision, minimal tissue trauma, and the development of many laser-improved and laser-specific procedures.

It is important when considering the two delivery systems to consider a number of factors relating to the ease of use, safety, maintenance, and, the impact each system has when used in surgery.

1. Ergonomics -

My experience (and that of thousands of colleagues) is that the thinner, flexible HWG and its pencil-thin handpiece are significantly easier and more comfortable for the surgeon to use than the thicker, more bulky AA system. The HWG system is essentially "weightless", counter-balanced by an adjustable weight. Cheaper AA systems have no counterbalance. Higher end AA systems use an adjustable spring counterbalance. While both systems respond well to the surgeon's movement, the consensus is the sheer size and bulk of the AA system results in more arm and hand fatigue.

Another important consideration is physical positioning of the device in surgery. The flexibility of the HWG allows for convenient positioning of the device and positioning of the handpiece over a mayo stand for ready access. The AA system doesn't always allow suspension of the handpiece at an appropriate height above a mayo stand, reducing ease of access. Also, because of a more limited range of motion, possible locations of the AA devices in surgery are more limited.

2. Precision –

The HWG system utilizes focusing tips held very close to the tissue, allowing phenomenal precision. The HWG handpiece is held much like a pencil, and is so precise simply because of its accuracy. It is aimed from a close distance, and allows the surgeon to gain maximum stability by resting the hand holding the handpiece on the patient.

AA delivery systems, which are held 2 to 3 cm from the tissue, and require an aiming beam, offer less precision and accuracy. Simply put, the farther from the target, the harder it is to aim. Likewise, having to hold the AA handpiece 2 to 3 cm from the tissue makes it harder to stabilize the handpiece by resting the hand on the patient.

Of critical importance is consideration of the aiming beam required by AA devices. The visible aiming beam is 10+ times greater in size than the actual laser beam making precision difficult. It's much like trying to aim a small bore rifle using the path of a cannon shell.

3. Availability of Multiple Spot Sizes –

Articulated arm devices offer one fixed spot size, usually .2 - .25 mm. HWG devices offer multiple size focusing tips, which can be quickly and easily changed during surgery. Experienced surgeons know the best results are obtained by adjusting the delivered beam according to tissue characteristics and desired effect. A single spot size simply doesn't produce the best effect in all situations. Multiple spot sizes are a significant advantage of the HWG devices.

4. Ability to Defocus –

Hollow waveguide focusing tips, having a focal length of 0.75 - 3 mm, produce a laser beam with a very wide angle of convergence and divergence. When backed away from tissue, beyond focal length, the laser beam begins to defocus rapidly. As the laser beam defocuses, the amount of laser energy delivered per unit area (power density, watts/cm^2) decreases.

Although maximal power density is desired for cutting or removing tissue, reduced power density can be used effectively for hemostasis and contracting tissue. Adjustment of power density can easily and rapidly be achieved with slight hand movement when using HWG devices.

Articulated arm handpieces utilize a focusing lens with a fixed 50 - 100mm focal length. Because of the long focal length, the laser beam has very narrow angles of convergence and divergence. To defocus an AA laser beam the handpiece must be backed away from the tissue a distance so great it removes this option from practicality. A significant reduction in power density can simply not be achieved with an AA laser by attempting to defocus.

5. Power –

Articulated arm lasers range in power from 10 - 12 watts to very high wattage depending on the model. The higher end models sold for veterinary surgery go up to 30+ watts. First generation HWG lasers were limited to 20 watts. The second generation HWG lasers released in 2006 have bridged that gap and now go up to 30+ watts as well.

6. Beam Configuration –

Just as with spot sizes, the best tissue effect is achieved by modifying beam configuration according to tissue characteristics. Because of factors beyond the scope of this article, the metal HWG laser tube allows more complex pulsing of the laser beam than the glass tubes used in AA devices. The result is that HWG lasers offer many "multiple pulse" modes not present in AA devices. Often overlooked by prospective buyers of CO_2 lasers, the advantage of having a diversity of multiple pulse modes is significant. Skilled laser surgeons quite often use these modes to achieve results otherwise unattainable.

7. Safety –

The most important safety consideration for CO_2 laser operators and surgery personnel is eye safety. Since the CO_2 laser beam is readily absorbed by water, the cornea is susceptible to CO_2 laser damage. Potential corneal damage is directly related to power density. Because of the wide angle of divergence of HWG focusing tips, and the rapid defocusing of the beam, the actual danger zone is relatively short with this system. With the very narrow angle of divergence of the AA focusing lens system the laser beam maintains high power density for a much longer distance. The potential danger zone is much greater with AA devices.

Another important safety consideration is the quality of the components inside the laser. It is well documented that some of the imported AA lasers lack a required laser beam attenuator or shutter and/or an internal power meter.

8. Maintenance –

A marketing ploy utilized by AA manufacturers and vendors is their claim that the hollow wave-guides (or "fibers") require frequent replacement. On the contrary, they are durable, reliable, and have a long life. (I have used a single HWG for as long as five years!)

Hollow waveguide lasers have a calibration feature so the laser is calibrated to the HWG each day. The surgeon knows that the power requested is the power being delivered. AA lasers utilize an internal power meter (when it is actually present – remember that some have been documented to not have this part). Internal calibration doesn't take into account the effect on the laser beam of the mirrors of the articulated arm nor of the lens of the handpiece.

9. Disposables –

In still another marketing ploy, much has been made by AA vendors about the cost of HWG disposables. HWG focusing tips *could* be disposed of after each use, but all users I know clean, autoclave, and re-use the tip dozens of times. Newer ceramic focusing tips have a virtually infinite life span. I simply do not hear complaints from HWG owners that tips are too costly because they are disposable.

Conclusions and Comments

For the reasons outlined above it has been my experience (and that of colleagues) that the HWG delivery system offers substantial advantages over the AA delivery system.

Hollow wave guide lasers are safer, more ergonomic, more precise, and allow greater surgeon control of beam configuration. The HWG focusing tip delivery system is more adaptable to the diversity of procedures done by veterinarians.

After presenting cases done with my HWG laser, a comment I often hear from those who own AA lasers is "I just can't do that with my laser." With sympathy I agree. I couldn't do many of my HWG laser procedures with my AA laser either.

Certainly, higher power AA lasers can cut tissue effectively. If the only thing I did in surgery was to make skin incisions, I would be very happy with my AA laser. But, since I do procedures much more complex than simply making skin incisions, my choice each day when selecting one of my lasers to use, is to turn on my hollow wave guide laser.