Videolaseroscopy for the Treatment of Endometriosis and Other Diseases of the Reproductive Organs

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Introduction

Laparoscopy in gynecologic applications has proven to be a cost effective and clinically efficacious technique. The adaptation of the laser to gynecologic laparoscopy, has greatly expanded the potential applications of laparoscopy in gynecology.

Laser laparoscopy has several inherent disadvantages. One difficulty is back strain for the operating physician, resulting from constantly bending over the patient's abdomen to visualize through the laparoscope, particularly during long procedures. Because the laparoscope only allows the use of one eye through a narrow aperture, the physician's field of view is limited and poor visualization of the peritoneal structure and pathology may result. Finally, since there is no way for the surgical staff to observe the surgical procedure within the abdomen, boredom often occurs leading to inattentiveness and poor assistance.

We have developed a new variation on laser laparoscopy that overcomes these disadvantages. We call this new modality *videolaseroscopy*. In this article, we will primarily discuss our technique and results with patients treated for edometriosis.

Instrumentation and Technique

The laparoscopes we use are the Eder 10.7 mm Laser Laparoscope (Edward Weck Co.,Research Triangle Park, NC), a Wolf 10 mm Laser Laparoscope (Richard Wolf Medical Instruments Corp., Rosemont, IL), or a Cabot 10 mm Laser Laparoscope (Cabot Medical, Langhorne, PA).

The lasers we have used to date during videolaseroscopy are a CO_2 laser (Sharplan 733, Advanced Surgical Technologies, Allendale, NJ) and a Cooper CO_2 laser (Cooper 500, Cooper-Lasersonics, Inc. Longwood, FL). The CO_2 laser is used through the operating channel of the laparoscope. A direct coupler is attached to the laparoscope. A 28 cm zinc arsenide lens is used in the coupler to focus the laser beam.

The CO_2 laser, a molecular gas laser, emits far infrared radiation with a wavelength of 10,600 nm.[1] The nonionizing radiation at this wavelength is absorbed by nonreflecting solids and liquids, and is particularly well absorbed by water. When the laser beam is applied to soft tissue, the radiation is absorbed by the water within the tissue and converted to heat. The rapidly heated water in the tissue is then converted to steam, which expands and explodes the irradiated cells. This results in the production of water vapor, cellular debris, and smoke, which is called the *laser plume*.[2] The tissue is then said to be vaporized.

For short applications of this energy, the vaporization process is confined to a depth of less than 0.1 mm below the surface and a surface area equivalent to the spot size of the incident laser beam. The spot size of a typical CO_2 laser beam, at the focal point, ranges from 0.2 to 0.8 mm in diameter, allowing very precise control of the size of the vaporized area. The production and release of steam in the plume, the shallow depth of absorption of the laser radiation, and the presence of water in the tissue surrounding the vaporized tissue all help to limit the depth of thermal damage below the vaporized tissue to a zone less than 0.5 mm deep. In experienced hands, this confinement of thermal damage can be used to remove lesions overlying vital structures in the peritoneum, such as the ureter, the bowel, or even blood vessels.

The laser can also be used for linear incisions (vaporization in a line), ablations (vaporization of tissue over an area of the surface), and excisions (vaporization of the tissue underlying and surrounding the lesion to lift the lesion off and preserve it for pathology). The CO_2 laser beam can also be used to coagulate soft tissue. During vaporization procedures, the heat of vaporization seals off the small capillaries and lymphatics less than 0.5 mm in diameter, creating a bloodless, dry, surgical incision or area of ablation.

This coagulation property can be enhanced by lowering the laser power and/or by spreading out the spot size of the laser beam (defocusing the laser with micromanipulator of the coupler or by increasing the distance from the tissue). The defocusing of the laser has proven very effective, not only in coagulating areas of oozing blood and lymph, but also in coagulating and shrinking small areas of the surface peritoneum. For example, low-power densities of 100 to 500 W/cm² are useful in coagulating and contracting the serosal surfaces of the hydrosalpinx, resulting in a turning back of the hydrosalpinx in a cuff fashion without the need for invasive sutures. We believe that the use of sutures on the tubes and ovaries could lead to the development of adhesions.

The laser videomonitoring technique we have developed and refined incorporates a miniature, laparoscope-mounted video camera, a videorecorder, and a high-resolution videomonitor in conjunction with the laser laparoscope. We have used both a Storz Videocamera (Karl Storz Endoscopy America, Inc.) and a Wolf Videocamera (Richard Wolf Medical Instruments CORP). interchangeably.

Videolaseroscopy allows the surgeon to operate in an upright position directly from the videomonitor, reducing the back strain and fatigue encountered in operating directly through the laparoscope. The surgeon can use both eyes while operating. The camera also allows the surgeon to "zoom" in on endometriosis and other pathology regardless of how deep in the pelvis it might be, helping to ensure that the disease is eradicated. By magnifying the tubes and ovaries, one can do microsurgery with videolaseroscopy. In addition, the camera enables the surgeon to operate from almost any angle

and position by rotating the camera. For example, we have treated numerous cases of anterior abdominal wall endometriosis that, traditionally, would have been missed and not treated at laparotomy or laparoscopy. Every case is videotaped so that a permanent record may be kept on each patient. This is especially helpful in patient education and it also provides any referring physician with a tape of the procedures.

The laser's beam can reach sites that would be more problematic using the scalpel, cautery, or suturing.

Technique for Endometriosis

Prior to surgery it is our practice to discuss with a patient the possibility of laparotomy, and more extensive procedures like colostomy or hysterectomy. Also, before treating a large endometrioma, we perform a careful laparoscopic assessment to reduce the chance of draining a pelvic malignancy. Cysts with the appearance of endometriomas are first aspirated for cytology. If malignancy is suspected, peritoneal washing is performed.

Videolaseroscopy procedures are performed under general endotracheal anesthesia with patients placed in the lithotomy position. The bladder is drained, and a cervical cannula is placed for manipulation of the uterus for intraoperative injection of diluted indigo carmine. Each patient receives 1 g of cefoxitin intravenously preoperatively and again in the recovery room as a prophylactic dosage.

After pneumoperitoneum induction, the operating laparoscope is inserted intraumbilically. A 5.5 mm second puncture trocar is then inserted in the midline approximately 2 to 4 cm above the symphysis pubis. A suction-irrigator probe (Cabot Medical, Langhorne, PA) is then introduced through the second puncture site. This probe has two trumpet valves; the surgeon can easily irrigate as this is connected by tubing to an I.V. bag on a pole with a pressurized cuff around the bag at 300 mmHg. The irrigation fluid consists of 5,000 units of heparin in 1 liter of lactated Ringer's solution. By pushing the other trumpet valve, the surgeon can easily suction any drainage or smoke generated by the laser. This valve is connected to the suction tubing. This enables the suction and irrigation to be easily available through one probe. When necessary, a third incision is made along the suprapubic line 2 to 4

inches from the second trocar. This allows other ancillary instruments to be inserted such as a titanium rod or atraumatic alligator grasping forceps (Eder Instruments Co., Chicago, IL) that may be required during surgery. All instruments used must be made of titanium or wire-brushed when used with the laser to prevent direct reflection of the laser beam from reflective surfaces.

A focused beam of 6,000 to 18,000 W (0.5 mm spot-size at a 15-45 W setting)was employed to vaporize endometriosis implants from the ovary, pelvic sidewall, cul-de-sac, tubes, uterosacral ligaments, bladder flap, and peritoneum or capsule of endometriomas. The continuous mode of the CO_2 laser is used. Endometriomas up to 15 cm in diameter and any peritubal or periovarian adhesions are also treated by laser lysis.

Larger endometriomas are aspirated and irrigated several times with a Wolf needle (Richard Wolf MEDICAL Instruments Corp., Rosemont, IL) and then with the suction irrigator probe after fluid is gathered for cytology. The endometriomas are bivalved and the capsule is dissected and as much as possible is removed. The base of the capsule is then vaporized. This is to make the ablation of the capsule complete, helping to ensure that the endometrioma does not persist and seal off small blood vessels.

After an area of endometriosis is vaporized, it is important to irrigate several times. This is to enable the surgeon to check that all endometriosis has been removed. It is also crucial to wash the area several times to remove the charcoal material from sites that have been vaporized, as remaining charcoal may cause adhesions. At the conclusion of the procedure, thorough irrigation helps to ensure that there is no bleeding before closing.

Videolaseroscopy gives the surgeon the ability to evaluate the ovaries closely to help ensure that all adhesions are lasered during the procedure. Lasering adhesions on the ovaries aids in the egg release. After all adhesions appear to have been vaporized, a final check is made by filling the pelvic cavity with the irrigation solution until the ovaries and tubes are floating in clear fluid. If any adhesions remain, they will flower out from the ovary or tube in the fluid. This enables the surgeon to see and remove any persisting adhesions that might otherwise be missed.

If significant oozing occurs from the lysis area, a Jackson/Pratt drain (Goleta, CA) can be inserted in the abdominal cavity for 12-24 hours. The patients are routinely discharged approximately 4 hours after surgery. Of the 631 patients who underwent videolaseroscopy of endometriosis, we have had no major side effects and the minor complications have been gas pain and bruises of the abdominal wall associated with laparoscopy.

At the end of the procedure great care is taken to remove as much smoke plume and CO_2 gas as possible. After removing the laser and coupler from the laser laparoscope, the suction irrigator is used in the abdomen for the final time, pushing the remaining smoke and gas out through the suction as well as through the top of the laser laparoscope. This appears to be helping with postoperative discomfort caused by remaining gas.

Of 156 women infertile because of endometriosis, 65% became pregnant subsequent to laser surgery.

Results

In the present study, a total of 631 patients underwent videolaseroscopy for the treatment of endometriosis. Of these, 441 patients presented with a complaint of infertility and 190 patients had pelvic pain or pelvic mass. Out of 441 infertility patients with endometriosis, 181 patients had at least one additional factor contributing to their infertility; in 260 patients, endometriosis was the only factor.[3]

Of the 260 patients with endometriosis as the sole contributing factor, 156 have been followed for at least 18 months. The classification and pregnancy rate of these 156 patients are shown in Table 1.

In summary, 102 out of 156 patients (65%) achieved pregnancy. The length of time to achieve pregnancy postoperatively for these patients is depicted in Table 2.

Among the 190 endometriosis patients with pelvic pain, 67 had[4] American Fertility Society Stage I, 73 had stage II, 27 had stage III, and 23 had stage IV.

The percentages of pain relief in these women is shown in Table 3.

Discussion

In comparison with hormonal therapy, videolaseroscopic treatment of endometriosis can be relatively simple and inexpensive, especially if it is effected at the same time as diagnostic laparoscopy.

When CO_2 laser is used through the videolaseroscope, the surgeon's line of vision and the beam are almost coincident, because they emerge from two different channels.

This is an important point for one to consider to prevent any inadvertent tissue damage.

The advantages of videolaseroscopy over laparotomy are a faster recovery period and a shorter hospital stay. Following videolaseroscopy the average hospital stay is 4 to 6 hours after the patient is brought to the recovery room; the maximum stay being 20 hours after surgery (one night stay). This compares to a routine hospital stay of 4 to 5 days for laparotomy patients and in some cases as long as 7 days.

In our endometriosis patients treated with videolaseroscopy we have very minimal blood loss, less than 20 cc. With this procedure, blood transfusion should not be necessary as is sometimes the case with laparotomy. The CO_2 laser seals small blood vessels less than 0.5 mm.

Due to very minimal handling of the tissue through laparoscopy, there is less trauma to the abdominal tissues. The incisions made are only large enough to accommodate a 10.7 mm primary trocar at the umbilicus and as many as 1 to 3 smaller incisions to accommodate ancillary instruments 5.5 mm in diameter along the pubic hairline. Smaller incisions decreased handling, trauma, and manipulation of the tissue, are other advantages of videolaseroscopy. Also, videolaseroscopy provides less ex-

posure of the abdominal cavity to the air, thereby reducing secondary dryness of tissue, eliminating glove powder. Producing less blood loss, requiring less suturing of tissue and, overall, reducing the chance of contamination. There is also potentially less danger of forming postoperative adhesions when compared to laparotomy.

Finally, use of the laser can preclude the formidable complications associated with the use of the cautery. The energy of the CO_2 laser is focused very precisely, so the tissue beyond 100 microns is unaffected. This precision allows destruction of endometriosis close to the vital structures such as the ureter, bowel or blood vesels when the surgery is performed by an experienced laser surgeon. The precision is not possible with cautery. The addition of the videocamera improves the surgeon's visibility with additional magnification, thereby complementing an already efficacious system.[5]

It should be emphasized that videolaseroscopy must be performed only by experienced operative laparoscopists who are able to operate from the monitor. This requires the surgeon to have extensive training and experience with the laser. It should not be attempted by inexperienced laparoscopists who are not comfortable with multiple puncture techniques. More advanced disease should be treated only when the surgeon thinks the procedure can be done as well as or better than if it were done via laparotomy.

In our opinion, the era of laparotomy for conservative management of mild to extensive endometriosis and endometriomas is at an end, no matter how severe the endometriosis.

As the potential applications for videolaseroscopy continue to expand, we believe that the majority of surgeries previously requiring laparotomy for conservative management of the reproductive organs will be replaced by videolaseroscopy.▲

References available upon request.

Table 1.
Classifications and Pregnancy Rate in 156 Patients with Endometriosis and Infertility After 18 Months Follow-up

STAGE (AFS)	NO. PATIENTS	PREGNANCY	PERCENT
I	31	24	77%
II	63	39	62%
III	41	25	61%
IV	21	14	66%
TOTAL	156	102	65%

Table 2.
Length of Time to Achieve Pregnancy After Surgery

No. of Months	No. of Patients	Percent Success Achieving Pregnancy
6 mos.	52	51%
6-12 mos.	40	39%
12-18 mos.	10	10%
6-18 mos.	102 (out of 156 total patients)	65%

Table 3.
Percent of Pain Relief in 1-12 Months Post Videolaseroscopy in 190 Patients With Endometriosis

	TOTAL RELIEF	PARTIAL RELIEF	NO RELIEF
1 Mo.	185 (97%)	5 (3%)	0 (0%)
6 Mos.	167 (89%)	18 (9%)	5 (3%)
9 Mos.	160 (84%)	23 (12%)	7 (4%)
12 Mos.	155 (82%)	25 (13%)	10 (4%)