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Laparoscopic Treatment of Endometriosis with Laser and Videocamera Augmentation (Videolaseroscopy)

CAMRAN NEZHAT, M.D., WENDY K. WINER, R.N., B.S.N., FARR NEZHAT, M.D., and CEANA NEZHAT, M.D.

ABSTRACT

Recent advances in laparoscopic surgery have enabled the gynecologic surgeon to treat an increased number of diseases of the reproductive organs by using the laser through the laparoscope. This article reviews the results of 857 patients with endometriosis who were treated using the CO_2 laser laparoscopically with videocamera augmentation (videolaseroscopy). Of 201 infertility patients followed for at least 18 months, 132 (66%) achieved pregnancy. Of 270 patients with pelvic pain, 210 (77%) patients experienced no pain after 1 year. We conclude that when surgical management of endometriosisis is indicated, videolaseroscopy offers advantages over standard laser laparoscopy for the surgeon, including reduced back strain and increased magnification control. In addition, comparable, if not improved, results to the patients can be obtained through laser laparoscopy with video augmentation. (J GYNECOL SURG 5:163, 1989)

INTRODUCTION

OPERATIVE LAPAROSCOPY HAS PROVEN to be a cost-effective and clinically efficacious technique in the treatment of endometriosis[1-4] The CO_2 laser has proven useful in situations requiring precise application, safety, and minimal tissue damage.[1,2] The fine beam provides precise control for the thorough vaporization or dissection of endometriosis through the laparoscope.[1,3,5,6] The use of the CO_2 laser through the laparoscope was first reported by Bruhat, et al.[7] in 1979 and later by Tadir et al.[8] Incorporation of videocamera and laparoscope in human and animal studies has been described before, and some of the advantages have been mentioned.[9-12] Because of various reasons, e.g., the heavy weight of the cameras, poor resolution of both cameras and monitors, and high cost, the use of videocameras in endoscopy did not become popular until recently.

This article discusses the results of treatment of 857 endometriosis patients laparoscopically using the CO_2 laser with videocamera augmentation. This method involves the use of a laser

Fertility and Endocrinology Center, Atlanta, Georgia.

videomonitoring technique incorporating a direct coupler, videocamera, videorecorder, and high resolution videomonitor in conjunction with the laser laparoscope (Fig. 1).

MATERIALS AND METHODS

One of two laser laparoscopes, either the Wolf 10 mm laser laparoscope (Richard Wolf Medical Instruments Corp., Rosemont, IL) or the Cabot 10 mm laser laparoscope (Cabot Medical, Langhorne, PA), was used during laser laparoscopy. A Lasersonics 500Z CO_2 laser (Heraeus, Lasersonics, Santa Clara, CA) was used through the operating channel of the laparoscope. A Nezhat coupler (Cabot Medical) was attached to the laparoscope. A 28 cm zinc arsenide lens in the coupler was used to focus the laser beam.

During the course of this study, a laser videomonitoring technique incorporating a miniature, laparoscope-mounted videocamera, a videorecorder, and a high-resolution videomonitor was employed. Storz (Karl Storz Endoscopy America, Inc., Culver City, CA), Wolf, and Cabot videocameras were used interchangeably. All three cameras provided high resolution of between 275 and 350 lines and quality tapes. The videorecorder was used to provide a permanent record on each patient.

Preoperatively, patients were counseled on the possibility of laparotomy. The procedures were performed under general endotracheal anesthesia, with patients placed in the lithotomy position. The bladder was drained, and a cervical cannula was placed for manipulation of the uterus and for intraoperative injection of diluted indigo carmine. Each patient received 1 g of cefoxitin sodium (Mefoxin) i.v. before surgery and again in the recovery room as a prophylactic dosage.

After pneumoperitoneum induction, the operating laparoscope was inserted intraumbilically. A 5.5 mm second puncture trocar was then inserted in the midline approximately 2–4 cm above the symphysis pubis. A Nezhat suction-irrigator probe (Cabaot Medical) was introduced through the second puncture site. This probe had two trumpet valves that could be regulated by the

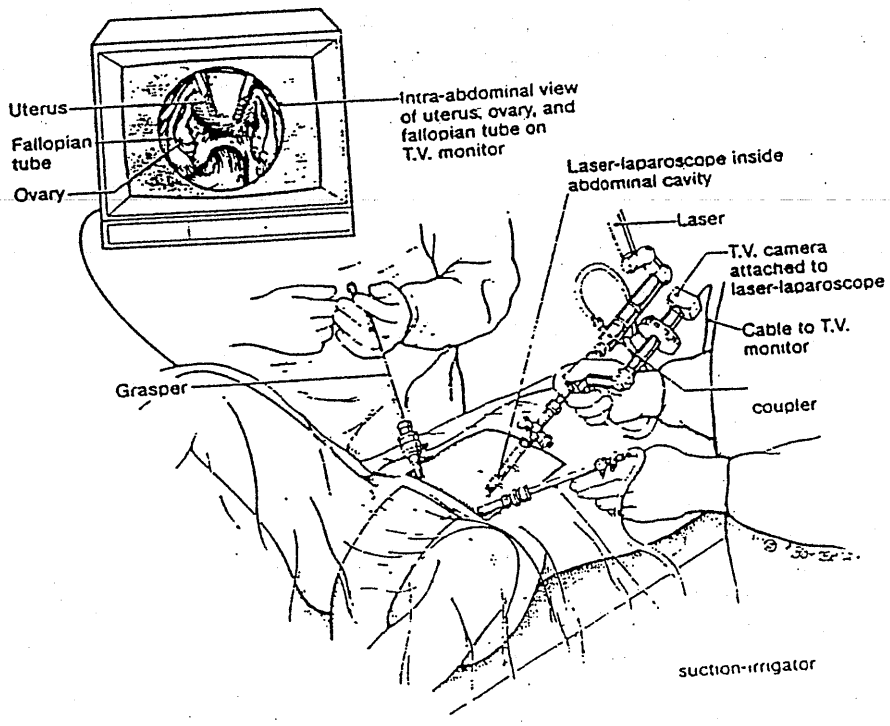

FIG. 1. Laser laparoscopy with video augmentation. Videolaseroscopy represents a refinement of current endoscopic procedures for the treatment of endometriosis.

surgeon's finger. By pushing one trumpet valve, the surgeon could easily irrigate, as the valve was connected by tubing to the Nezhat Irrigation pump (Cabot Medical). Irrigation pressure up to 800 mm Hg was obtainable with this pump for hydrosurgery. A setting of 300 mm Hg was used for routine irrigation. The irrigation fluid consisted of 5000 units of heparin in 1 liter of lactated Ringer's solution. By pushing the second trumpet valve, which connected to the suction tubing, the surgeon could easily evacuate any drainage or smoke generated by the laser. When necessary, a third 5.5 mm incision was made along the suprapubic line 10 cm from the second trocar. This allowed any additional ancillary instrument, such as an atraumatic grasping forceps, to be used if necessary when more extensive disease was present.

The laser was used in the superpulse mode (500 pulses/second and a 1.0 msec pulse width), with the average power to tissue being 40 W. A 1.0 mm spot size was used with an average power density to tissue of approximately 4,000 W/cm^2. This setting was used to remove or vaporize endometrial implants from such areas as the ovaries, pelvic sidewall, cul-de-sac, tubes, uterosacral ligaments, bladder flap, rectum, bowel, or capsule of endometriomas. The superpulse mode of the CO_2 laser was used throughout the procedures.

Before treating a large endometrioma, careful laparoscopic assessment, on the lower and upper abdomen, including the liver, was done to reduce the chance of draining a malignancy. Cysts that had the appearance of endometriomas were first aspirated, and the fluid obtained was sent for cytologic evaluation. If there had been suspicion of malignancy, peritoneal washing would have been performed, and a gynecologic oncologist would have been consulted.

When the cyst was opened, the videocamera was used to zoom in on the internal wall to examine it for excrescent tumor (cystoscopy). If tumor was found, a frozen section was taken. After fluid was gathered for cytology, large endometriomas were aspirated and irrigated several times with a Wolf aspirating needle and then with the Cabot suction-irrigator probe. The endometriomas were bivalved, and the capsule was dissected, with the surgeon removing the capsule. The base of the capsule was then vaporized. Even when removal of an endometrioma was performed using a nontraumatic alligator grasping forceps, vaporization was performed on the base of the capsule for the purpose of sealing off the small blood vessels and contracting the capsule and approximating the edges of the ovaries.

After vaporization of an area of endometriosis, the area was irrigated several times. Repeated irrigation enabled the surgeon to check for thorough removal of all endometrial implants. Charcoal material also was removed from vaporized sites by washing the area numerous times. At the conclusion of the procedure, the area was irrigated to check for clear fluid in the pelvic cavity to ensure that there was no bleeding and also to have a clean pelvis.

After all adhesions appeared to have been treated, a final check was made by filling the pelvic cavity with the irrigation solution until the ovaries and tubes were floating in clear fluid. Remaining adhesions would be evidenced by flowering out from the ovaries and tubes in the fluid and were lased at this time. No invasive sutures were used on the tubes or ovaries.

At the end of the procedure, the smoke plume and CO_2 gas were removed. After removal of the laser and coupler from the laparoscope, the suction-irrigator probe was used in the abdomen for the final time to push remaining smoke and gas out through the suction as well as through the top of the laparoscope. Patients were routinely discharged within 24 hours after surgery.

RESULTS

In the present study, 857 patients underwent videolaseroscopy for the treatment of endometriosis. Of those patients, 587 had a complaint of infertility, and 270 had pelvic pain or pelvic mass. Of the 587 infertility patients, 386 had at least one additional factor contributing to their infertility. In the remaining 201 patients, endometriosis was the only infertility factor. These 201 patients have been followed for at least 6 months (Table 1). Of 32 patients with stage I American Fertility Society endometriosis,[1] 25 conceived, giving a pregnancy rate of 78%. Forty-six (62%) of 74 patients with moderate or stage II AFS endometriosis became pregnant, 36 (64%) of 56 patients with severe or stage III AFS endometriosis conceived, and 25 (64%) of 39 patients with extensive or stage IV AFS endometriosis conceived.

TABLE 1. CLASSIFICATION AND PREGNANCY RATE IN 201 PATIENTS WITH INFERTILITY AND ENDOMETRIOSIS DURING 6–18 MONTH FOLLOW-UP AFTER SURGERY

Stage (AFS)	*No. of patients*	*No. of pregnancies*	*%*
I	32	25	78
II	74	46	62
III	56	36	64
IV	39	25	64
Total	201	132	66

One hundred thirty-two (66%) of 201 patients conceived. Of those 132 pregnancies, 65 (49%) occurred in the first 6 months after surgery. Fifty-two patients (39%) conceived 6–12 months postoperatively, and 15 (11%) conceived 12–18 months postoperatively (Table 2).

Of the 270 patients with pelvic pain, 70 had AFS stage I endometriosis, 90 had stage II, 54 had stage III, and 56 had stage IV. Of those 270 women, 250 (92%) experienced nearly total relief, defined as cramps only during menses, at 1 month, 220 (81%) at 6 months, and 210 (78%) at 12 months (Tables 3, 4). Fifteen patients (6%) felt partial relief, defined as being able to continue normal activity but requiring medication for pain, at 1 month, 40 (15%) at 6 months, and 45 (16%) at 12 months. Five patients (2%) felt no relief, defined as being unable to continue normal activity and requiring medication for pain, at 1 month, 10 patients (3%) at 6 months, and 15 patients (6%) at 12 months.

No major side effects were experienced by the 857 patients in this study. Those minor complications reported include gas pain and bruises of the abdominal wall associated with laparoscopy. Two patients had intended laparotomies, one with cancer of the ovary, and the other with endometriosis involving the mucosa of the bladder.

DISCUSSION

The CO_2 laser offers precise application, safety, minimal tissue damage, and excellent hemostatic properties. Through the laparoscope, precise control for the dissection or vaporization of endometriosis for implants is possible using the laser's fine beam, with little risk of thermal damage to adjacent structures.[1,7] The use of the superpulse mode of the CO_2 laser further reduces thermal damage.[14]

In addition to the established benefits of the laparoscope for the treatment of endometriosis, it is our experience that video augmentation provides the surgeon with an improved view of the peritoneal structure and pathology. Videolaseroscopy also enables the surgeon to magnify small lesions to treat the disease more effectively and thoroughly and to provide better outcomes. Adequate and thorough evaluation of the abdomen is essential in the treatment of endometriosis. The videocamera can be used to zoom in on the tissue. If scarring or fibrosis is seen on the bladder or rectum, it should be evaluated and completely treated. When fibrosis was encountered in the pararectal area and rectosigmoid colon, it was vaporized. During the procedure, a surgical assistant performed a rectal examination, with the surgeon using the assistant's finger as a guide for treating the disease. Fibrosis and endometriosis on the colon or appendix were vaporized very carefully without damaging the mucosa of the bowel. We must admit that perhaps the only

TABLE 2. LENGTH OF TIME TO ACHIEVE PREGNANCY AFTER SURGERY IN 201 INFERTILITY PATIENTS

No. of Months	*No. of pregnancies*	*%*
0–6	65	49
6–12	52	39
12–16	15	11
Total	132	66%

TABLE 3. STAGING OF 270 PATIENTS WITH ENDOMETRIOSIS AND PELVIC PAIN

Stage (AFS)	*No. of patients*
I	70
II	90
III	54
IV	56
Total	**270**

way to ensure complete removal of disease when the entire thickness of the wall is involved would be bowel resection, although we question its necessity at all times.

When lasering around endometrial implants, the surgeon should vaporize a wide margin in a circular manner and vaporize the serosa. In addition, the surgeon should attempt to remove whatever tissue possible for biopsy at the time of treatment. We treat all disease no matter how mild it may appear. A patient's complaint of pain always should be taken seriously, and the pelvis should be evaluated thoroughly at the time of laparoscopy.

Traditionally, surgeons left the areas around the bladder and rectum untreated when applying cautery or knife methods to avoid damaging the tissue. However, the precision of the CO_2 laser allows the surgeon to treat these areas when endometriosis is found. It may be necessary to increase the laser power gradually to treat the disease effectively. Although it is not absolutely necessary to use the laser through the laparoscope to treat all areas of endometriosis, bleeding often occurs when using the knife or scissors. By using the superpulse mode of the CO_2 laser, most bleeding can be stopped at the time of vaporization and removal of the endometriosis. If bleeding is not corrected with the laser, cautery is used.

In addition to allowing the surgeon a better field of vision to treat the disease completely, we have found that video augmentation relieves the back strain often associated with laparoscopic procedures by allowing the surgeon to operate in an upright position.

Video augmentation also leads to improved interest and assistance by the surgical team when they are able to follow the procedure on the videomonitor. Furthermore, a videorecording of the procedure is available for patient education and for the referring physician when there is one. The tapes have voice-overs to describe to patients the areas being treated.

In terms of efficacy of treatment, this study compares favorably with published pregnancy rates for conservative surgery using the laser laparoscope alone.[1,15] We have found that when conservative surgical management of endometriosis is indicated, videolaseroscopy offers definite advantages to the surgeon and probably improved results to the patient when compared to other modalities of treatment, for example, medical therapy and laparotomy.[1,5,15]

We have avoided suturing the ovaries because we believe that sutures could cause adhesion formation.[4] After aspirating and removing the capsule of the endometrioma, the ovary collapses on itself without the need for sutures. The laser can be used at reduced power to approximate the edges of the ovary together.

It must be emphasized that videolaseroscopy should be performed only by experienced operative laparoscopists who are comfortable operating from the videomonitor. This requires that the surgeon have extensive training and experience operating with multiple probes directly from the monitor. This procedure should not be attempted by surgeons unfamiliar with multiple puncture techniques. More advanced disease should be treated only when the surgeon is

TABLE 4. PAIN RELIEF AT 1–12 MONTHS POSTLASER LAPAROSCOPY WITH VIDEO AUGMENTATION IN 270 PATIENTS WITH ENDOMETRIOSIS

Time period (months)	*Near total relief*	*Partial relief*	*No relief*
1	250 (92%)	15 (6%)	5 (2%)
6	220 (81%)	40 (15%)	10 (3%)
12	210 (78%)	45 (16%)	15 (6%)

nfident that videolaseroscopy can be done as well as or better than laparotomy. In addition, hen using the CO_2 laser through the laparoscope, the surgeon's line of vision and the beam are most coincident because they emerge from two different channels. This point must be kept in ind to prevent inadvertent tissue damage.

We have found that videolaseroscopy is an excellent choice for the treatment of diseases of ie reproductive organs, particularly endometriosis. The ideal laser for laparoscopy would be a O_2 laser with high power capabilities and no alignment problems, and one that produces a inimal amount of smoke[16] or none at all. Although both the argon and KTP-532 lasers produce ss smoke than the CO_2 laser, these lasers do not possess the same high power capabilities. In ddition to the decreased power provided with these fiber lasers, their flexible fibers easily break r melt when used at their highest power settings of only 12–14 W.[17] These lasers are more uitable for coagulation than dissection.

As potential applications for video augmentation expand with videocameras and monitors mproving continuously in resolution and clarity, we predict that videolaseroscopy will replace he majority of surgeries previously requiring laparotomy for conservative management of liseases of the reproductive organs.[18–21]

REFERENCES

1. Kelly RW, Roberts DK. CO_2 laser laparoscopy: Potential alternative to danazol in the treatment of stage I and II endometriosis. J Reprod Med 1983;28:638.
2. Chong A, Baggish M. Management of pelvic endometriosis by means of intraabdominal carbon dioxide laser. Fertil Steril 1984;41:14.
3. Nezhat C, Crowgey SR, Garrison CP. Surgical treatment of endometriosis via laser laparoscopy. Fertil Steril 1986;45:778.
4. Ellis H. The aetiology of post-operative abdominal adhesions—An experimental study. Br J Surg 1962;50:10.
5. Nezhat C, Winer WK, Crowgey SR. Videolaseroscopy for the treatment of endometriosis and other diseases of the reproductive organs. Obstet Gynecol Forum 1987;1:1.
6. Nezhat C. Videolaseroscopy. A new modality for the treatment of endometriosis and other diseases of the reproductive organs. Colposc Gynecol Laser Surg 1986;2:221.
7. Bruhat M, Mage C, Manhes M. Use of the $C0_2$ laser via laparoscopy. In: Kaplan I, ed. Laser surgery III. Proceedings of the Third International Society for Laser Surgery. Tel Aviv: International Society for Laser Surgery, 1979:275.
8. Tadir Y, Kaplan I, Zuckerman Z, Edelstein T, Ovadia J. New instrumentation and technique for laparoscopic carbon dioxide laser operations. A preliminary report. Obstet Gynecol 1984;63:582.
9. Nezhat C, Winer W, Crowgey S. Videolaseroscopy for treatment of endometriosis and other diseases of the reproductive organs. Obstet Gynecol Forum 1987;1:1.
10. Bush M, Seater SWJ, Wildt DE. Laparoscopy of zoo mammals. In: Harrison RM, Wildt DE, eds. Animal laparoscopy. Baltimore: Williams & Wilkins, 1980:169.
11. Kott DF. Photography, cinematography and television in endoscopy. In: Phillips JM, ed. Endoscopy in gynecology. Downey, CA: American Association of Gynecologic Laparoscopists, 1978:487.
12. Yuzpe AA. Television in laparoscopy. In: Phillips JM, Corson SL, Keith L, et al., eds. Laparoscopy. Baltimore: Williams & Wilkins, 1977:306.
13. The American Fertility Society. Classification of endometriosis. Fertil Steril 1985;32:633.
14. Badawy SC, ElBakry MM, Baggish MS. Comparative study of continuous and pulsed CO_2 laser on tissue healing and fertility outcome in tubal anastomosis. Fertil Steril 1987;47:5.
15. Davis GD. Management of endometriosis and its associated adhesions with the CO_2 laser laparoscope. Obstet Gynecol 1986;68:3.
16. Nezhat C, Winer W, Nezhat F, Nezhat C, Forrest D, Reeves W. Smoke from laser surgery: Is there a health hazard? Lasers Surg Med 1987;7:376.