

# Excision of Endometriosis Superficial Bowel Serosa Using an Ideal Energy Source for Precise Dissection over a Vital Structure

**LASER USED:** UltraPulse™ Carbon Dioxide (CO<sub>2</sub>) Free-beam Laser.

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The UltraPulse carbon dioxide (CO<sub>2</sub>) free-beam laser, as a non-contact cutting tool, is singular in its ability to excise tissue exactly and with a minimum of lateral thermal injury. These unique properties make excision over even delicate vital structures - like the bowel - possible with precision and reproducibility.

## Case Introduction

### Anatomy & Definition:

Endometriosis is mostly found in dependent areas of the female pelvis and can also be encountered on the bowel, large and small (Fig.1). In order to achieve optimal clinical outcomes (for both pain and fertility), complete surgical excision should be achieved when possible.



Figure 1: Endometriosis on the bowel

### Patient History & Symptoms:

Patient is a 29 year-old woman complaining of pelvic pain and period-related dyschezia. Patient denies hematochezia. Patient has failed to have symptom improvement with hormonal suppression. Patient desires fertility preservation or improvement.

### Relevant Physical Findings & Diagnostics:

- A physical and complete pelvic exam reveals tenderness of the uterosacral ligaments (right worse than left), but no palpable adnexal masses nor rectovaginal nodules are felt.
- Preoperative assessment with transvaginal ultrasound is critical in looking not only for suspicion of ovarian endometriomas, but also is recommended to evaluate for deep endometriosis in the rectovaginal space. If bowel lesions are found that involve the bowel muscularis, a combination procedure with a general or colorectal surgeon can be planned to allow for a single “one-step” surgery, without surprises or the need for a subsequent surgery.

- Transvaginal ultrasound with rectal preparation is performed which indicates a thickening of the anterior rectum, but without involvement of the bowel muscularis, located about 10 cm from the anal verge. There is no evidence or suspicion of ovarian endometriomas.

### Diagnosis:

- Presumptive diagnosis includes:
  - o Endometriosis
  - o Bowel endometriosis not involving the muscularis layer

## Preoperative

### Treatment Management & Objective:

- Medical management or hormonal suppression is used to improve symptoms and/or to prevent disease progression. Medical management does not destroy or remove endometriosis, has not been shown to help fertility<sup>1</sup>, and the need for its early or prolonged use has been correlated to be a marker for more advanced disease<sup>2,3</sup>. As such, medical management is at best useful only for temporary symptom improvement.
- Complete excision of all abnormal appearing peritoneum suspicious for endometriosis - both typical and atypical - down to normal tissue, with minimal lateral thermal injury, is the preferred and most effective form of treatment of the disease<sup>4</sup>. Complete excision of endometriosis depends on two things: (1) recognition of all appearances of the disease - both typical and atypical<sup>5</sup>, and (2) on complete removal of the disease wherever it is found.
- Once all the abnormal peritoneum suspicious for endometriosis has been identified, it must be completely removed, even over vital structures such as the bowel. Excision gives assurance that the disease is completely removed with minimal thermal injury or ‘char’, even in cases of nodular or deep disease, retraction pockets, or a large patch of disease. Most energy sources have disadvantages for excision which include the need to contact

the tissue (with the possibility of pushing too far), the lack of a precise cutting edge, or a larger zone of lateral thermal injury that can lead to distortion of vital structures. The UltraPulse carbon dioxide (CO<sub>2</sub>) free-beam laser, as a non-contact cutting tool, is singular in its precision and controllable depth of penetration, while minimizing lateral thermal injury, making it an ideal tool for excision even over vital structures.

- Excision allows the surgeon to accurately remove all the disease down to normal tissue. The plane between abnormal and normal tissue can be identified, and thus the disease can be removed completely. The UltraPulse free-beam CO<sub>2</sub> laser, when used properly, is an ideal tool for excision on the large or small bowel, without 'puckering' of the tissue or loss of function of the organ (Fig. 2).
- NOTE that it is strongly recommended that a bowel surgeon be involved in cases where excision of endometriosis occurs on the large or small bowel. This provides a team approach to the treatment of endometriosis, and a bowel surgeon can help advise on whether the bowel serosa should be oversewn and help with any needed repair.



Figure 2: Bowel after laser excision of endometriosis

- Post-operative adhesion formation after surgical treatment of endometriosis must be minimized for both pain and fertility. An important change agent that can lead to adhesion formation is thermal impact on the normal tissue left behind after excision. The UltraPulse carbon dioxide (CO<sub>2</sub>) free-beam laser, with its minimum of lateral thermal spread and char formation, is an excellent tool for excision.

- The use of the UltraPulse laser saves a lateral port since the freebeam cutting tool is being fired down the shaft of the operative laparoscope (Fig. 3). In addition to the port for the operative laparoscope at the umbilicus, only two lateral ports are needed for exposure, traction, and irrigation-suction in a 3-port approach (Fig. 4). With other energy sources used for excision, a 4-port approach is needed, especially in moderate-severe disease cases.



Figure 3: Laser laparoscope

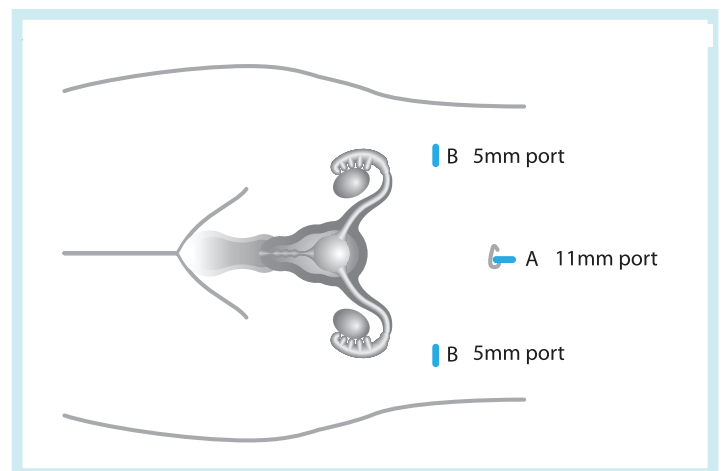


Figure 4: 3 port incisions

## Major Equipment & Instrumentation

- CO<sub>2</sub> Laser: Lumenis UltraPulse
- Operative Laparoscope: Storz: 26075AAS
- Laser Coupler: Lumenis Nezhat Coupler # 0617-621-01
- Laser Adapter: Lumenis Nezhat Adapter # 0617-612-03
- Suction Irrigator: Bard / Davol, Inc. REF: 5552003
- Grasper, Forceps : Jarit / Winer 600-123
- Bi-Polar: Karl Storz / Robi 38121
- Vessel Sealing: Covidien / Ligasure REF: LF1537
- Port 5 mm: Applied Medical CFF03 & CFS02
- Port 12 mm: Applied Medical COR4 a 7All but one patients

## Patient Preparation

- Patient positioning is very important to allow for both patient safety and an optimal operative environment. The goals of patient positioning include the following :
  - Avoidance of nerve muscle or nerve injuries of the extremities, including legs, arms and feet
  - Avoidance of sliding of the patient when in steep Trendelenburg
  - To allow of optimal ergonomic position of the surgeon while operating
- The legs must be in a lithotomy position, and ideally one that allows for versatile access to the area between the legs. We use Allen stirrups which are adjustable. It is important that there is no more than 90 degrees of flexion at the hip and knee joints, and that there is no lateral pressure of the knee area in the boot which can lead to a peroneal nerve injury in prolonged cases. A good rule of thumb is to line up the toe, knee and opposite shoulder for a comfortable patient position.

- The arms must be tucked, with the hands in the position of function (thumbs up). We use foam to wrap about the elbow joint and completely around the hands. The arms are tucked using a sheet (folded lengthwise) laying under the lower third of the patient, which then wraps arounds the arms and under the mattress in an "inside out" manner.
- There are different methods for preventing sliding of the patient. We choose to use egg-crate foam (egg crates facing upward) that is taped to the operating table and three points – lower, middle and upper. The patient then lies directly on the egg crate foam (except for the sheet used for tucking the arms) and laying under the lower used for wrapping the arms under the lower third of the foam. It is important to ensure that the foam is no wider that the operating table. This method of preventing sliding is effective with minimal cost.
- Surgeon positioning is critical for preventing musculoskeletal injuries, especially for longer cases. Having the arms tucked is critical to allow for the surgeon to stand in a position that is comfortable and ergonomic, while operating the laser. The elbows of the surgeon should be comfortable beside the body, the neck be in-line with the body and the back straight, and eyes looking forward and at or slightly below the horizontal plane. This is accomplished by usually: (1) having the surgeon elevated (on a step) depending on their height, (2) standing at a level of about the ear of the patient, and (3) having the monitor directly in from of the surgeon, across from the opposite leg.

### Insufflation & Smoke Evacuation:

- Plume produced by the CO<sub>2</sub> laser during excision (especially over fat) can be a problem for visualization and proper functioning of the laser. We deal with this issue by having continuous adjustable evacuation of plume from one lateral port, and double insufflation (each set at 20 liters/min - one attached to the other lateral port, and one attached for the operative scope itself ) to keep up with maintaining the intradominal pressure of 15 mmHg without breaks or time lapses.

## Laser Excision Technique

### Surgical Procedure & Technique:

Setting 15 Watts UltraPulse (can be lowered to 10 or 12 Watts over the bowel or other delicate tissue) with 125 milli-Joules pulse energy, the laser is used to circumscribe the lesion in situ, without previous hydrodissection. A 'margin' of normal tissue around the lesion (as described in the oncology literature) is not needed as long as the lesion is completely circumscribed. The depth of penetration of the CO<sub>2</sub> laser is a predictable 'one layer at a time' (about 1mm at above power levels) as long as the free-beam is kept moving at a steady rate learned through experience. The bright red aiming beam allows for pinpoint precision. The area is circumscribed until an edge is raised in the peritoneum or serosa.

The inside edge of the circumscribed area is then grasped and elevated. The tissue is now retracted, usually in the contralateral direction, to expose the junction between the lesion or peritoneum and the normal underlying tissue. Continuous adjustment of the traction on the specimen to be excised is critical since: (1) the CO<sub>2</sub> laser cuts more efficiently when there is traction on the tissue being cut, and when the beam is perpendicular to the tissue, and (2) the specimen should be retracted to avoid vital structures in the line of the beam as best as possible. When able, a backstop should be employed behind the tissue being incised to protect vital structures as an added margin of safety.

The free-beam laser is used in such a manner as to ensure that the entire lesion is excised completely. This involves directing the laser (using the target aiming beam) at or below the plane of where the abnormal tissue meets the normal tissue. Blunt and sharp dissection is used to reduce vital structures away from plan of dissection. The dissection is continued until the entire lesion has been undermined and can be removed. Copious irrigation is used to maintain a clear field and proper visualization.

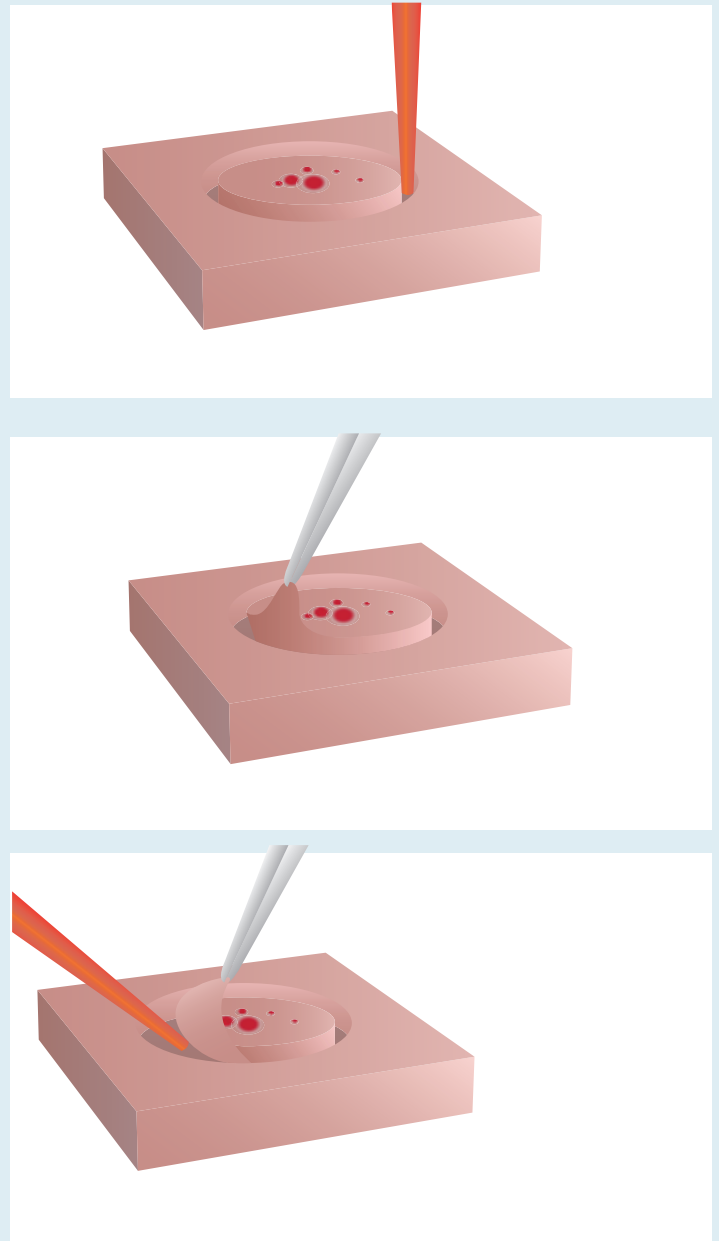


Figure 5

## Operative

### Surgical Procedure & Technique:

- The distinct advantages of the UltraPulse CO<sub>2</sub> free-beam laser are highlighted in this case - complete and precise excision, minimal thermal injury, and minimal adhesion potential - when endometriosis is found on a vital and sensitive structure like the large and small bowel.
- After areas of endometriosis have been identified, excision is begun. At present, we will focus on a nodular area of disease (though not involving the bowel muscularis) over the large bowel, and a superficial area of disease over the small bowel.
- Our preoperative transvaginal ultrasound with rectal preparation indicates that there is a bowel nodule of the serosa, not involving the muscularis. Excision of this lesion is possible without damaging the bowel muscularis, and the Ultrapulse CO<sub>2</sub> free-beam laser is the cutting tool of choice to do so.
- To begin for the large bowel, the rectal probe is used to expose and locate the lesion or nodule, then to retract the bowel away from the plane of incision (Fig. 2). The begin for the small bowel, the suction irrigator is used to elevate the bowel from behind (Fig. 6). For this type of delicate tissue dissection, the laser power is lowered to 10 or 12 Watts (at 125 mJ). The photo shows that the lesion on the small bowel has been outlined (Fig. 7).
- The laser has precisely machined out a shallow trench of tissue (Fig. 7). Note that very little of the surrounding tissue is being impacted by the laser beam; there is minimal char, tissue distortion or 'puckering' of the bowel. Only the serosa has been incised. This kind of precision with minimal lateral injury is unique compared to any other energy source.
- Now, the laser is used to undercut the lesion completely, taking care to remove the disease from 'under the roots' (Fig. 8) Notice the precision of the laser after the tissue is excised without tissue distortion or evidence of significant thermal injury, and with sharp edges and minimal char (Fig. 9).
- NOTE that it is strongly recommended that a bowel surgeon be involved in cases where excision of endometriosis occurs on the large or small bowel. This provides a team approach to the treatment of endometriosis, and a bowel surgeon can help advise on whether the bowel serosa should be oversewn and help with any needed repair.

### Laser Devices & Technique:

- Laser system: Lumenis UltraPulse CO<sub>2</sub> laser
- Laser accessories:
  - Lumenis: Nezhat laser laparoscope coupler, # 0617-621-01
  - Lumenis: Nezhat laser laparoscope adapter, # 0617-612-04
  - Storz: Operative laparoscope, # AA26036, 5mm operating channel
- Technique: as described above. The specific capabilities of the UltraPulse mode (high pulse energies at select powers for treatment speed) are essential to achieve the level of precision described in this case.

### Laser Parameters:

- For Lumenis UltraPulse CO<sub>2</sub> laser:
  - 15 Watts UltraPulse, 125 millijoules pulse energy
- In general for the UltraPulse CO<sub>2</sub> laser:
  - The higher the power setting, the higher the treatment speed
  - The higher the pulse energy setting, the smaller the thermal impact is
  - For more tissue impact control, use the footswitch with a shuttered laser exposure or select Timed and Repeat Exposure modes on the user interface.

### Hemostasis:

- If bleeding occurs, point coagulation is used to precisely control bleeding with minimal dessication of surrounding tissues. We use a reusable bipolar device (as above) for smaller vessels, and have a separate device available for larger vessels as needed. The CO<sub>2</sub> laser is used as a cutting tool, and should not be used to coagulate vessels.

### Other Technique Tips:

- The safe use of the Ultrapulse CO<sub>2</sub> laser requires proper use and maintenance of the equipment, proper hands-on training, and adequate first-hand experience.
- Fluid saline absorbs laser energy, so that the frequent use of irrigation on normal adjacent tissues offers protection from an inadvertant laser beam.
- If there is a significant defect in the bowel serosa, it can be oversewn. Defects in the muscularis should definitely be oversewn, in a one or two-layer closure.
- Adhesions and Adhesion Barriers: Due to the minimum of devitalized tissue or char present after excision with the CO<sub>2</sub> laser, adhesion barriers are optional for serosal or peritoneal defects.



Figure 6

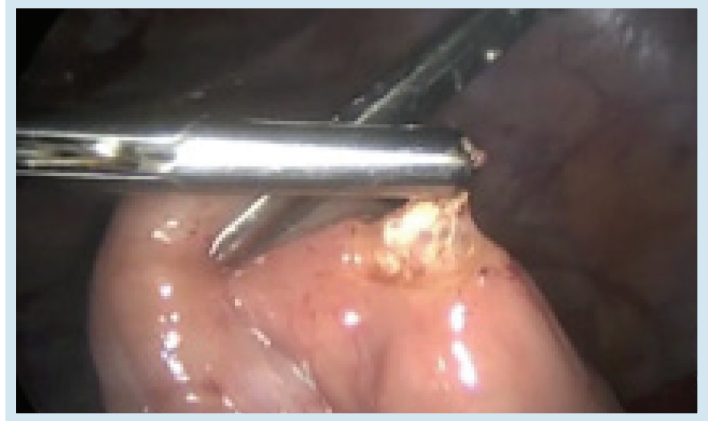


Figure 8



Figure 7



Figure 9

## Postoperative

### Discharge, Recovery & Outcome

- Patients are usually discharged the same day of surgery, once all the recovery unit requirements are met.
- It is possible, and we feel it is important, to keep the umbilical incision within the borders of the umbilical crater or basin for an optimal cosmetic result. The umbilical wound is dressed with gauze and Tegaderm (under negative pressure) for several days which gives an excellent cosmetic result. The lateral ports are placed low

(2 cm medial to the anterior superior iliac spine (ASIS)), after pneumoperitoneum has been achieved, which allows them to be out of sight of the midabdomen and able to be covered with undergarments or swimwear. These lateral wounds are dressed usually only with steri-strips on the skin, and then covered with gauze and Tegaderm.

- We routinely see the patients in follow-up within 2 weeks, at which time the pathology results are reviewed with the patient.

Summary, Pearls & Pitfalls

- The UltraPulse laser is singular in its ability to excise tissue exactly as intended and with a controllable depth of penetration, and should be regarded as the cutting tool of choice of delicate vital structures. Complete disease removal, even over areas such as the large and small bowel can be achieved. Results of complete excision by expert surgeons give excellent clinical outcomes for both pain and fertility
- The UltraPulse produces a particular confined area of thermal injury. This is advantageous to avoid tissue distortion, preserve organ functionality, and to minimize adhesion formation.
- Laser treatment speed can be changed easily by adjusting laser power. Thermal impact can be tuned by adjusting pulse energy level in UltraPulse mode. Starting at 125 mJ:
  - o Higher pulse energy generates less thermal injury
  - o Lower pulse energy generates somewhat higher thermal injury and aids hemostasis
- Some of the CO<sub>2</sub> insufflation gas is continuously entering the laser laparoscope and streaming down the operative channel to avoid thermal blooming and keeping it clear from smoke which can impede the laser beam.
- The safe use of the UltraPulse carbon dioxide (CO<sub>2</sub>) free-beam laser requires proper use and maintenance of the equipment, proper hands-on training, and adequate first-hand experience through a learning curve.

References

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Risk Information

CO<sub>2</sub> lasers (10.6 μm wavelength) are intended solely for use by trained physicians. Incorrect treatment settings or misuse of the technology can present risk of serious injury to patient and operating personnel. The use of Lumenis CO<sub>2</sub> laser is contraindicated where a clinical procedure is limited by anesthesia requirements, site access, or other general operative considerations. Risks may include excessive thermal injury and infection. Read and understand the CO<sub>2</sub> systems and accessories operator manuals for a complete list of intended use, contraindications and risks.



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