Gas Embolism during Intrauterine Laser Surgery

ECRI has investigated two incidents of fatal gas embolism that occurred during intrauterine Nd:YAG laser surgery at different hospitals. CO₂ was used to distend the uterus in one of the incidents, while liquid was used in the other. In both cases, a fiberoptic delivery system with coaxial air fiber cooling was used. The procedures were done without the use of a sapphire contact tip, and the laser was activated at times while the fiber tip was in contact with endometrial tissue.

During irradiation, especially when directly contacting the tissue, minute vessels may be opened before ultimate coagulation or fusion. Gas flow from the tip of the coaxial fiber cooling system proximate to the uterine wall, facilitated by the intrauterine pressure necessary to distend the organ, leads to seepage of gas into the venous system. Although the duration of laser activation was relatively short in both of the reported cases (less than a minute in one case), massive venous gas embolism occurred rapidly. Sufficient gas rapidly accumulated in the venous vasculature and displaced most or all of the blood in the heart. Irreversible cardiac arrest ensued.

For diagnostic hysteroscopy, the uterus is typically insufflated with CO₂ to facilitate visualization, while for hysteroscopic Nd:YAG laser surgery, a liquid distention medium (e.g., physiologic saline solution) is preferred because it achieves better visibility (dense bubbles may result during bleeding in a gas environment) and minimizes the risk of gas embolism through vessels opened during the procedure. Nd:YAG quartz fibers normally require some form of cooling to protect the tip from overheating caused by reflected or backscattered energy. Fibers designed for coaxial cooling through a sheath surrounding the quartz fiber (depending on the manufacturer’s recommendations) may be cooled by a gas (i.e., air or CO₂) or a liquid.

The choice of air, CO₂, liquid, or no coaxial coolant depends on the clinical application. The appropriate technique for using Nd:YAG and other lasers in the uterus depends on such factors as the substantial gas flow at the tip of a coaxially cooled fiber tip emitted directly at irradiated tissue (flows typically are in the range of 200-2,000 mL/min), which may be continuous (i.e., independent of laser activation); gas distention of the uterine wall at pressures typically in the range of 50-100 mm Hg; the dense vascularity of the endometrium and myometrium; tissue contact vs. noncontact technique; and patient positioning (i.e., Trendelenburg) with the uterus raised above the heart.

In many Nd:YAG procedures (outside of the uterus), it has become convenient to use the gas flow from the fiber tip during coaxial cooling to blow away debris at the treatment site and minimize tissue deposition on the fiber tip. However, in most cases, bare fibers (without the coaxial cooling sheath) are used in spaces or cavities filled with a liquid without the need for additional cooling. A liquid distention medium provides superior visualization, permits adequate cooling of a bare laser delivery fiber, and reduces the risk of gas embolism. [Vascular fluid overload is a reported complication of fluid distention during certain hysteroscopic Nd:YAG endometrial ablation techniques for the treatment of menorrhagia, but is regarded as significantly more manageable and presents less risk than gas embolism.] Consequently, CO₂ gas or air should never be used as a fiber coolant during intrauterine laser surgery. In addition, only liquid should be used to distend the uterus during intrauterine laser surgery.

Laser, hysteroscope, and insufflator operator’s manuals may not explicitly warn about the dangers of gas embolism during laser surgery.
embolism associated with intrauterine laser surgery. In addition, laser clinical training may not adequately address this issue, and OR personnel responsible for setting up the laser for such a case may not be instructed in the appropriate fiber type or fiber coolant requirements. Furthermore, incidents of this type underscore the need for hospitals to mandate appropriate physician education, training, and preceptorship related to the use of lasers. Although we are aware of gas embolism associated with hysteroscopic laser surgery using the Nd:YAG laser only, we believe that similar precautions should be followed during hysteroscopic surgery regardless of laser wavelength.

**ACTION RECOMMENDATIONS**

- Alert your laser safety officer and appropriate medical and nursing staff to this Risk Analysis.
- Advise gynecologists using lasers never to use air or gas for fiber cooling or uterine insufflation during hysteroscopic laser surgery.
- Laser safety officers should make all laser technicians aware of this Risk Analysis and encourage them to implement these precautions when preparing for and conducting hysteroscopic laser surgery.
- Consider taking additional measures, such as placing a copy of this Risk Analysis in each laser operator’s manual and affixing the following label in a conspicuous location near the laser aperture, to ensure that current and new personnel are aware of this hazard:

  **WARNING:** Never use air or gas for fiber cooling or uterine insufflation during hysteroscopic laser surgery or other applications that may present the risk of gas embolism.