Seeing the Invisible: How ICG Technology Is Transforming Laparoscopic Surgery

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In recent years, modern surgery has undergone a quiet revolution, one driven not by larger machines or bigger incisions, but by light. Among the most remarkable innovations is the use of Indocyanine Green (ICG), a special dye that allows surgeons to visualize structures that would otherwise remain invisible to the naked eye. In laparoscopic surgery, where precision is everything, ICG has become one of the most powerful tools available today

What Is ICG?

Indocyanine Green is a dye that has been used safely for decades in medical imaging. When injected into the bloodstream, or into specific tissues, it binds to proteins and travels through blood vessels or lymphatic channels.

What makes ICG special is that it glows under near-infrared (NIR) light. Using a special camera attached to the laparoscope, surgeons can switch between normal vision and NIR "fluorescence mode," instantly revealing highlighted tissues in real time.

ICG is non-toxic, very safe, and its effect disappears naturally from the body within hours.

Why Use ICG in Laparoscopic Surgery?

Laparoscopic operations are performed through tiny incisions, with minimal direct visibility. Surgeons rely on cameras and instruments to work within delicate, complex anatomical spaces.
ICG greatly enhances this ability by providing real-time fluorescent imaging, allowing surgeons to:

1. Identify Bile Ducts in Gallbladder Surgery

One of the most important uses of ICG is in laparoscopic cholecystectomy.
By injecting the dye before surgery, the cystic duct, common bile duct, and biliary tree light up clearly under NIR light.
This significantly reduces the risk of bile duct injury, one of the most feared complications in gallbladder removal.

2. Evaluate Blood Flow During Colorectal Surgery

ICG fluorescence allows the surgeon to assess how well blood is reaching the intestine before joining two ends together (anastomosis).
Poor blood flow increases the risk of leakage.
With ICG, surgeons can instantly confirm healthy perfusion, lower complications and improve healing.

3. Locate Sentinel Lymph Nodes in Cancer Surgery

In cancers such as stomach, colon, cervical, or endometrial cancer, ICG can map lymphatic drainage and highlight the sentinel lymph nodes, the first nodes to which cancer may spread.
This allows more accurate staging and avoids unnecessary removal of multiple lymph nodes.

4. Visualize Ureters and Blood Vessels

In complex pelvic or abdominal surgeries, ICG can make vital structures glow, helping surgeons avoid accidental injury and operate with greater confidence.

5. Assess Liver Function and Map Tumors

Because ICG is processed by the liver, it provides valuable information on liver perfusion, function, and tumor margins.

In liver resections, some tumors appear as dark shadows against a fluorescent background, guiding safer removal.

Benefits for Patients

ICG's impact on patient outcomes is significant:
- Lower complication rates
- More accurate and safer surgeries
- Smaller incisions and faster recovery
- Better cancer staging and tailored treatment
- Reduced operating time in many procedures

For the patient, ICG technology often means a smoother postoperative course and a reduced risk of re-operation.

Is ICG Safe?

Yes. ICG has an excellent safety profile, with allergic reactions being extremely rare (less than 0.05%). It is rapidly cleared by the liver, making it suitable even for pediatric and elderly patients in most cases.

The Future: AI Meets Fluorescence

As surgery enters the era of artificial intelligence, the combination of ICG imaging + AI-enhanced cameras will soon allow:
- Automatic recognition of anatomy
- Real-time alerts before dangerous dissections
- Quantitative analysis of blood flow
- Smarter decision-making during cancer surgery

ICG is no longer just a dye, it is becoming a guiding light in precision surgery.

A Quiet Revolution With a Bright Impact

From gallbladder operations to cancer resections, ICG technology is reshaping how surgeons see the human body. By illuminating hidden structures, improving safety, and empowering surgeons with real-time information, it represents one of the most meaningful advances in modern minimally invasive surgery.

For patients, this technology offers reassurance: behind every incision lies not only surgical skill, but a new level of vision, one that brings together innovation, safety, and humanism in the Operating Room.