ICG-ENHANCED NIR FLUORESCENCE IMAGING IN LAPAROSCOPIC GASTRIC CANCER SURGERY

Han-Kwang YANG, Seong-Ho KONG, Yun-Suk SUH and Hyuk-Joon LEE
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Han-Kwang Yang, Seong-Ho Kong, Hyuk-Joon Lee and Yun-Suk Suh (left to right).
1 Introduction

1.1 Basic Concepts of ICG-Enhanced Fluorescence

In 1852, George Gabriel Stokes described the mineral Fluorite as emitting blue light following exposure to ultraviolet light. He termed the phenomenon as ‘Fluorescence’ and proposed that chemical compounds offering this property be called ‘Fluorophores’.21

The ability to emit fluorescence is very common in nature. The photosensitivity of delocalized electrons in aromatic ring structures is responsible for this. The absorbed light energy excites the delocalized electrons into a higher state of energy. When the electrons return to the ground state, the absorbed light energy is emitted as fluorescence. The emitted fluorescence is lower in energy as the absorbed exciting light energy is partially lost as heat.19

The oldest known approved near-infrared (NIR) fluorescent dye in medicine, indocyanine green (ICG), has been discovered as a chemical compound suited for use in NIR fluorescence-guided surgery.

ICG is a drug which has been approved for use in humans by the FDA since 1959 for cardiac and liver function tests. The tricarbon dye has an absorption maximum of $\lambda_{Ex} = 805$ nm and an emission maximum of $\lambda_{Em} = 835$ nm. On account of the inherent property of ICG to emit light in the NIR spectral range (wavelength of 700–900 nm), disturbing effects of autofluorescence that may arise from the main blood components (hemoglobin and water) are virtually impossible. The tissue penetration depth of ICG/NIR-enhanced fluorescence ranges between 0.5 cm and 1 cm.1,16,17

Most commonly, ICG is intravenously administered where it binds to plasma proteins (albumin) thereby remaining in the bloodstream due to size exclusion. From the bloodstream, ICG is transported to the liver, where it is excreted via the bile into the duodenum. This exclusive excretion into bile makes it an ideal compound for delineation of the extra-hepatic biliary tree.

In addition to bile duct imaging, ICG can be used for perfusion assessment as well as for visualization of lymph channels and lymph nodes.
2 Sentinel Lymph Node Dissection with ICG-Enhanced NIR Fluorescence Lymphangiography

2.1 Epidemiology and Background

Gastric cancer is the 5th most common cancer in the world according to GLOBOCAN 2012 data, and is ranked 3rd for the incidence of cancer-related mortality. Irrespective of the historical debate and ongoing controversy among experts in western and eastern countries, the use of lymph node dissection in gastric cancer surgery has gained widespread acceptance in the worldwide community of surgeons. In Asian countries, where a significant proportion of patients are diagnosed with early-stage gastric cancer through routine screening programs, NIR imaging technology is considered a promising cutting-edge imaging solution for sentinel lymph node (SLN) mapping and dissection. The emerging technique of ICG-enhanced NIR fluorescence imaging can be used effectively to tailor the extent of lymph node dissection to the individual patient, which in turn can help to reduce the rate of postoperative complications associated with extended lymphadenectomy. Additional benefits that can be derived from the new technique include preservation of organ function and improved quality of life. In Western countries, where most patients with gastric cancer are diagnosed at an advanced stage of the disease, and where many surgeons are not familiar with a more extended radical lymph node dissection, ICG-enhanced NIR fluorescence lymphangiography is used as a safe tracer method that allows to improve the accuracy of detection and to enable a less radical lymph node dissection. In conclusion, the use of this method is suited to improve intraoperative surgical staging and can ultimately lead to a better oncological outcome and a higher survival rate.

The use of ICG-enhanced fluorescence-guided lymph node mapping in gastric cancer surgery offers some advantages over other modalities employing radioisotopes (e.g., Technetium radiocolloid) and vital dye tracers (e.g., methylene blue, patent blue), which are currently known to provide the best sensitivity and specificity for sentinel lymph node mapping. ICG-enhanced NIR fluorescence imaging is a method that obviates the need to adhere to a specific safety protocol against the radiation hazards associated with the use of radioisotopes.

ICG-enhanced NIR fluorescence imaging for real-time detection of lymph nodes is superior to modalities using vital dyes in that it offers a higher tissue penetration depth and better signal-to-background ratio. However, in order to validate the accuracy of this new method, additional studies with a larger number of patients are needed prior to implementing it in routine clinical practice. In view of its good dispersion properties, ICG can also be used as a tracer to guide and evaluate extensive lymph node dissection, especially in the D2 area and in some parts of the D1 region (Fig. 2.1).
2.2 Injection Sites and Timing of ICG Administration

ICG can be administered either by submucosal injection under flexible gastroendoscopy or laparoscopic subserosal injection. The authors prefer the use of submucosal injection (with a 23-gauge endoscopic needle introduced through the flexible scope’s working channel) because during or after subserosal injection, there is an elevated risk of ICG leakage which can significantly compromise the goal of fluorescence guidance.

The typical working concentrations of the ICG solution prepared with commercially available lyophilized powder formulations are either 2.5 mg/mL or 5.0 mg/mL in sterile water, respectively, if the dilution is prepared as prescribed. In vitro studies performed by the authors have shown that the ICG fluorescence signal reaches its highest level of intensity at a final concentration of 0.05 mg/mL. In terms of injection volume, a bolus of 0.5–1.0 mL should be prepared for each injection site, if administered 15–30 minutes prior to dissection. When ICG is injected at higher concentrations, some lymph nodes are prone to accumulate ICG which can lead to a focal reduction in fluorescence intensity during the initial post-injection period, a phenomenon also known as ‘quenching’.

A fluorescent NIR signal will be noticeable once the diffusing ICG is diluted enough with the surrounding lymph fluid. In cases where ICG is administered at a higher concentration, the agent will be dispersed more widely into the soft tissue surrounding the lymph nodes. During the continuing course of the operation, the dye can leak and the resulting high intensity of the signal can interfere with detection of fluorescence from the lymph nodes.

ICG can remain in the lymph nodes and lymphatic network for several days, which is why injection of the dye 1–2 days before surgery can be used as an alternative to intraoperative injection if the operating room is not equipped with a flexible endoscopy system. To date, no well-designed clinical trial has been conducted to compare intraoperative and preoperative injection techniques, however, preliminary evaluation suggests that intraoperative injection is associated with a higher probability to visualize the lymphatic channels between the injection site and the lymph nodes, which can offer additional visual information to trace and identify the draining lymph nodes.

Fig. 2.2 Near-infrared (NIR) fluorescence signals of indocyanine green (ICG) at different concentration levels.

- a. The in vivo NIR image of the small bowel in a pig shows bright signals in the lymph nodes with an ICG concentration of 0.1 mg/ml or higher. The signals were weak at first and then became brighter as ICG was diluted with 1 and 5 mg/ml ICG, however, as a result of the quenching effect (red arrows), a dark area remained in the center of the injection site.

- b. The ex vivo NIR image demonstrates the resulting signal sizes at various injection sites / concentration levels in the porcine stomach. Note that 0.1 mg/ml is the optimal concentration level of ICG, with the smallest signal size at the injection site and a signal intensity sufficient to visualize lymphatic flows with the least quenching effect.

By courtesy of the International Gastric Cancer Association and the Japanese Gastric Cancer Association. Original article: Kong S et al. (2015).

Fig. 2.3 In vitro color image (a) and in vitro NIR image (b) of ICG dye (values are in mg/ml) diluted in cryotubes. Macroscopic color image of the porcine stomach (c). An ICG concentration level of 0.1mg/ml seemed to be optimal because it was correlated with the smallest signal size at the injection site and good visualization of lymphatic flows with the least quenching effect.
2.2.1 Injection Sites
The decision as to which ICG injection site to choose is essentially made between two options according to the predefined purpose. A peritumoral site can be selected to detect lymph nodes that drain from the tumor. Alternatively, the injections can be placed along the lesser and greater curvatures to stain perigastric level-1 and level-2 nodes. For sentinel lymph node mapping, the surgeon may opt for peritumoral injections (4 or more injections placed around the tumor). Considering that the lymphatic pathway between the injection site and the lymph nodes often becomes visible, this should permit the first draining sentinel nodes to be distinguished from other nodes (Fig. 2.4). Most commonly, the authors inject the ICG solution 15–30 minutes prior to the beginning of surgery, thus the sentinel lymph node can be detected through ICG-enhanced NIR fluorescence imaging well within this time frame.

In cases where ICG-enhanced NIR fluorescence imaging is used to guide the surgeon during extensive lymph node dissection, one may choose to place several injections along the lesser and greater curvature allowing the dye to be dispersed more widely to the lymph nodes surrounding the stomach; e.g., the prepyloric antrum, the angular notch, the cardia in the lesser curvature, the antrum, the lower body, and the midbody in the greater curvature, if a distal gastrectomy is planned.

Fig. 2.4 Sentinel lymph node detection with ICG-enhanced NIR fluorescence imaging 15–30 min after ICG injection. Laparoscopic image of the operative site taken during standard white light mode (a). Peritumoral submucosal injection of ICG was performed under flexible endoscopy. Note the linear signal (arrowheads) (ICG/NIR mode, b) marking the lymphatic channels and the sentinel lymph nodes (arrow).

Fig. 2.5 Lymph node station #8a (ICG/NIR mode, b), one of the level-2 stations, is clearly noticeable by NIR fluorescence after placing several injections of ICG solution along the lesser and greater curvature.
ICG-enhanced NIR fluorescence imaging is helpful in differentiating lymph nodes from non-lymphatic soft tissues (Fig. 2.6), as well as in assessing the completeness of lymph node dissection.

![Fig. 2.6](image)

**Fig. 2.6** Infrapyloric area after pylorus-preserving gastrectomy. The nodular soft tissue mimicking a lymph node (arrowhead, a) without showing any signs of fluorescence was in fact confirmed to be adipose tissue. Conversely, some soft tissue which under white light mode is not identified as being of lymphatic type can be detected under ICG/NIR mode (arrow, b).

### Gastrointestinal Perfusion Assessment

The occurrence of anastomotic leakage – a major complication after gastric cancer surgery – has been observed in 0.7% to 2.2% of cases. Postoperative anastomotic leakage has a significant impact on the patient’s life because it is associated with prolonged hospital stay, more reoperations and higher mortality rates, which ultimately poses a major economic burden on the health system.9,10,14

In order to decrease the risk of anastomotic leakage, adequate tissue perfusion has been identified as a major factor contributing to the success of intestinal anastomosis.2 The penetration depth of ICG-enhanced NIR fluorescence (not only through blood but also tissue) ranges between 0.5 cm and 1 cm.1,16,17 Several studies investigating the efficacy of fluorescence-guided perfusion control during colorectal anastomosis surgery confirmed that the technique has a great potential to reduce the rate of anastomotic leakage, if applied on a routine basis.5,6

Real-time ICG-enhanced NIR fluorescence imaging can be used effectively to evaluate blood perfusion of gastrointestinal tract anastomosis after radical cancer surgery.3,4 The following scoring system (Table 3.1) has been proposed to evaluate the perfusion status.18

<table>
<thead>
<tr>
<th>Score</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical assessment</strong></td>
<td>Dusky appearing bowel</td>
<td>Patchy appearing bowel</td>
<td>Bowel appearing pink, but no pulsatility or bleeding cut edges</td>
<td>Bowel appearing pink, pulsatility of mesenteric vessels, and bleeding cut edges, but clinical concern regarding viability</td>
<td>Bowel appearing pink, pulsatility of mesenteric vessels, bleeding from cut edge of bowel</td>
</tr>
<tr>
<td><strong>Fluorescence</strong></td>
<td>No uptake</td>
<td>Patchy fluorescence</td>
<td>Significantly hypofluorescent, but homogenous</td>
<td>Somewhat hypofluorescent compared to other segments</td>
<td>Iso-fluorescent to all other segments</td>
</tr>
</tbody>
</table>

*Table 3.1* Scoring system for assessment of anastomotic perfusion as proposed by Sherwinter DA et al. 2013.18
Vascular diffusion of ICG into the anatomical area of interest occurs rapidly following IV infusion (approx. 10–30 sec. up to 4–5 min., depending on dosage) and the fluorescence visualization remains stable for several minutes. The residual fluorescence diminishes within 10–15 min. which is addressed with the administration of a second dose of ICG, if desired. Taking into account the extremely low contraindication rate and a maximum recommended daily dosage of 2–5 mg/kg, multiple dose administration of ICG is extremely safe and effective when required.

The amount of ICG administered via a peripheral vein can be 2.5 – 5.0 mg, which is similar to that used for evaluation of gastric conduit perfusion in Ivor-Lewis esophagectomy. Higher concentration levels of ICG can be used safely, e.g., 0.2 mg/kg, as used in colorectal surgery or even up to 0.5 mg/kg. Systemically injected ICG initially causes the liver to appear very bright. Therefore, the hepatic background fluorescence around the area of interest should be masked by using some material such as gauze pledgets as a cover.

It should be noted that ICG eventually spreads to poorly perfused areas, which is why perfusion assessment is better done within a few minutes post-injection.
Summary and Discussion

ICG-enhanced NIR fluorescence-guided imaging is a new method that offers a high signal-to-background ratio and deeper penetration depth as compared to vital dyes. It is recommended for use as an alternative option in gastric cancer surgery for lymph node mapping. Sentinel lymph nodes as well as lymphatic channels between the tumor and the nodes can be identified after peritumoral injection of the ICG dye. Several injections placed along the lesser and greater curvature of the stomach can be used to disperse the agent more widely to the lymph nodes in the D1 and D2 area. Such a course of action is believed to be helpful in complete D2 dissection and to enable a well-tailored lymph node dissection during function-preserving surgery. Intravenous injection of ICG allows to visualize the perfusion around the anastomosis, which can provide additional information about its patency and integrity. The authors believe that this novel technique will be very helpful to surgeons who are not familiar with D2 lymph node dissection. Apart from that, experienced surgeons may also draw specific advantages from the use of ICG-enhanced fluorescence NIR imaging, particularly regarding accuracy and completeness of surgery as well as in terms of safety.
ICG-Enhanced NIR Fluorescence Imaging in Laparoscopic Gastric Cancer Surgery

References


The KARL STORZ OPAL1® Technology for ICG-Enhanced NIR Fluorescence Imaging in Laparoscopic Gastric Cancer Surgery
OPAL1® Technology for NIR/ICG
based on IMAGE1 S™ camera system

1. IMAGE1 S™
   - brilliant FULL HD image quality
   - NIR/ICG fluorescence in standard mode or SPECTRA A* mode

2. NIR/ICG telescope and camera head
   - 3-chip FULL HD camera head with high resolution, optimal NIR light sensitivity
   - telescopes for optimal fluorescence excitation and detection; can be used for white light and fluorescence modes
   - telescopes with various lengths and diameters

3. D-LIGHT P light source (Xenon light source)
   - best daylight spectrum in white light and fluorescence modes
   - no additional security measures (vs. Laser)
   - with enhanced background display

4. Footswitch
   - fast switch between white light and fluorescence mode

5. Autoclavable fiber optic light cable
   - optimal light transmission in the white light and NIR spectral range

* SPECTRA A: Not for sale in the U.S.

It is recommended to check the suitability of the product for the intended procedure prior to use.
ICG-Enhanced NIR Fluorescence Imaging in Laparoscopic Gastric Cancer Surgery

**OPAL1® Technology for NIR/ICG**

based on IMAGE1 S™ camera system

- **Camera system**
- **Camera control unit**
- **Light source**
- **Camera head**
- **Light cables**
- **Telescopes**
- **Open surgery**

**IMAGE1 S CONNECT™**

TC 200

**IMAGE1 S™ H3-LINK**

TC 300

**D-LIGHT P/ 20 1337 01-1**

Spare lamp: 20 1330 28
lamp modul: 20 1337 25

**H3-Z Fl**

TH 102

**Fiber Optic Light Cables**

495 NAC/NCSC/TIP/NCS/VIT

**HOPKINS® Telescope**

26003 ACA/BCA/AGA/BGA
26046 ACA/BCA

**VITOM® II ICG**

20916025 AGA
Accessories:
28272 UGN/CN
28272 HC
28172 HR/HM
Recommended Instrument Set

26003 BCA  1 x HOPKINS® Forward-Oblique Telescope 30°, enlarged view, diameter 10 mm, length 31 cm, autoclavable, for indocyanine green (ICG), fiber optic light transmission incorporated, for use with Fiber Optic Light Cable 495 NCSC, Fluid Light Cable 495 FO/FR and Cold Light Fountain D-LIGHT P SCB 2013701-1, color code: red
   alternatively:

26046 BCA  1 x HOPKINS® Forward-Oblique Telescope 30°, enlarged view, diameter 5 mm, length 29 cm, autoclavable, for indocyanine green (ICG), fiber optic light transmission incorporated, color code: red

495 NCSC  1 x Fiber Optic Light Cable, with straight connector, extremely heat-resistant, with safety lock, diameter 4.8 mm, length 250 cm

30160 GYG  3 x Trocar, with conical tip, with Luer-Lock connector for insufflation, size 6 mm, working length 10 cm, color code: black, including:
   Cannula
   Trocar only
   Valve Seal

3003 GYG  1 x Trocar, with conical tip, with Luer-Lock connector for insufflation, size 11 mm, working length 10 cm, color code: green, including:
   Cannula
   Trocar only
   Valve Seal

3010 GYG  1 x Trocar, with pyramidal tip, with Luer-Lock connector for insufflation, size 13.5 mm, working length 10 cm, color code: blue, including:
   Cannula
   Trocar only
   Valve Seal

30141 RS  1 x Reducer, to reduce from 11 to 5 mm

30142 RS  1 x Reducer, to reduce from 13.5 mm to 5 mm

33351 CC  2 x CLICKLINE CROCE-OLMI Grasping Forceps, rotating, with connector pin for unipolar coagulation, size 5 mm, length 36 cm, fenestrated, curved, single action jaws, including:
   Plastic Handle, without ratchet, with larger contact area
   Outer Tube, insulated
   Forceps Insert

33352 C  2 x CLICKLINE Bowel Grasper, rotating, with connector pin for unipolar coagulation, size 5 mm, length 36 cm, fenestrated, double action jaws, including:
   Plastic Handle, with MANHES style ratchet, with larger contact area
   Outer Tube, insulated
   Forceps Insert

33351 ML  1 x CLICKLINE KELLY Dissecting and Grasping Forceps, rotating, with connector pin for unipolar coagulation, size 5 mm, length 36 cm, long, double action jaws, including:
   Plastic Handle, without ratchet, with larger contact area
   Outer Tube, insulated
   Forceps Insert

34310 MA-D  1 x CLICKLINE Scissors Insert, with Outer Sheath, curved, double action jaws, spoon-shaped jaws, length of blades 17 mm, size 5 mm, length 36 cm, sterile, for single use, package of 10

33151  1 x CLICKLINE Plastic Handle, without ratchet, with larger contact area at the finger ring, with connector pin for unipolar coagulation

37370 DL  1 x Coagulating and Dissecting Electrode, with channel, L-shaped size 5 mm, length 36 cm, for use with suction and irrigation handles

30810  1 x Handle, for suction and irrigation, autoclavable, for use with 5 mm coagulation suction tubes and 3 and 5 mm suction and irrigation tubes
   alternatively:

37113 A  1 x Handle, pistol grip, with clamping valve, for suction and irrigation, autoclavable

30173 LAR  1 x Dismantling KOH Needle Holder, ergonomic axial handle with disengageable ratchet, ratchet release on right side, left curved jaws, with tungsten carbide insert Ø 5 mm, length 33 cm, including:
   Insert
   Outer tube
   Handle

26173 AM  1 x BERCI Fascial Closure Instrument, for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm

30623 UR  1 x CUSCHIERI Retractor, size 10 mm, length 36 cm
   including:
   Insert
   Outer Sheath
   Handle
HOPKINS® Telescopes

**HOPKINS® Forward-Oblique Telescope 30°**, enlarged view, diameter 10 mm, length 31 cm, **autoclavable**, for indocyanine green (ICG), fiber optic light transmission incorporated, for use with Fiber Optic Light Cable 495 NCSC, Fluid Light Cable 495 FQ/FR and Cold Light Fountain D-LIGHT P SCB 20133701-1, color code: red

**HOPKINS® Forward-Oblique Telescope 30°**, enlarged view, diameter 5 mm, length 29 cm, **autoclavable**, for indocyanine green (ICG), fiber optic light transmission incorporated, color code: red
Trocars and Accessories

Size 6 mm, 11 mm, 13.5 mm

The New Trocar Generation from KARL STORZ
The new trocar generation combines single-use and reusable components. In line with the KARL STORZ company philosophy, the cannulas and trocars were designed with reusable components in mind. The valve seal is intended for single use.

Special Features:
- Ergonomic shape of the trocar ensures safe and comfortable handling during placement of the trocar
- One-piece sealing system for single use
- Minimal friction between the valve seal and the instrument
- Considerably reduced weight and good balance thanks to the newly designed plastic trocar housing
- Color coding for clear identification of different sizes
- Available in the sizes 2.5 mm – 13.5 mm

30160 GYG Trocar, with conical tip, with LUER-Lock connector for insufflation, size 6 mm, working length 10 cm, color code: black
including:
Cannula
Trocar only
Valve Seal

30103 GYG Trocar, with conical tip, with LUER-Lock connector for insufflation, size 11 mm, working length 10 cm, color code: green
including:
Cannula
Trocar only
Valve Seal

30108 GZG Trocar, with pyramidal tip, with LUER-Lock connector for insufflation, size 13.5 mm, working length 10 cm, color code: blue
including:
Cannula
Trocar only
Valve Seal

30141 RS Reducer, to reduce from 11 to 5 mm

30142 RS Reducer, to reduce from 13.5 mm to 5 mm
Single-use Scissors
CLICKLINE – rotating, dismantling

Size 5 mm

Operating instruments, length 36 cm, for use with trocars size 6 mm

Special Features:
- Scissor blades are always sharp and/or optimal cutting effect
- Sterile packed for immediate use in the OR
- Proven scissor blade design
- Compatible with all handles from the CLICKLINE series (without ratchet)
- Packaging
- Cost-effective solution: “single-use meets reusable”

The single-use scissors are delivered in packages of 10 in a dispenser box with instructions for use.

Each scissors insert with outer sheath, including 3 patient labels, are sterile packed in an individual blister pack.

34310 MA-D CLICKLINE Scissors Insert with Outer Sheath, curved, double action jaws, spoon-shaped jaws, size 5 mm, length 36 cm, sterile, for single use, package of 10

34310 MS-D CLICKLINE METZENBAUM Scissors Insert with Outer Sheath, curved, double action jaws, size 5 mm, length 36 cm, sterile, for single use, package of 10
Dissecting and Grasping Forceps
CLICKLINE – rotating, dismantling, insulated, with connector pin for unipolar coagulation

Size 5 mm
Operating instruments, length 36 cm

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<td>33310 C</td>
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<td>CLICKLINE Forceps Insert, bowel grasper, double action jaws, fenestrated</td>
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<td>CLICKLINE Forceps Insert, KELLY dissecting and grasping forceps, double action jaws, long</td>
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KOH Macro Needle Holders
dismantling

KOH Macro Needle Holder, size 5 mm, dismantling, consisting of:
- Handle
- Outer sheath
- Working insert

Cleaning and sterilization are gaining increasing importance for KARL STORZ as a manufacturer of surgical instruments. Similar to all our surgical instruments, the cleaning and hygiene of our needle holders also play an important role. Our KOH macro needle holders feature consistent effectiveness and precision, with significantly improved cleaning results achieved by dismantling the instrument. The handle, outer sheath and inner part can be cleaned and sterilized separately for perfect results.

The reusable dismantling design offers the user the following benefits:
- Can be disassembled into three separate components
- Fully autoclavable
- Cleaning connector
- Choice of six different handles and three different working inserts
- With tungsten carbide inserts
- Environmentally correct: In the event of damage, only the component with the defect needs to be replaced
- User-friendly and ergonomic handling
Handles and Outer Sheaths

KOH Macro Needle Holders, dismantling

Handles, axial and pistol-shaped, with disengageable ratchet

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<td>30173 AO</td>
<td>Handle, axial, with disengageable ratchet, ratchet position on top</td>
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<tr>
<td>30173 PO</td>
<td>Handle, pistol-shaped, with disengageable ratchet, ratchet position on top</td>
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Metal Outer Sheaths

Size 5 mm

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<tr>
<td>30173 A</td>
<td>Metal Outer Sheath, with LUER-Lock connector for cleaning, size 5 mm, length 33 cm</td>
</tr>
<tr>
<td>30178 A</td>
<td>Same, length 43 cm</td>
</tr>
</tbody>
</table>
**KOH Macro Needle Holders**

dismantling

**Size 5 mm**

Operating instruments, lengths 33 and 43 cm, with axial handle for use with trocars size 6 mm

<table>
<thead>
<tr>
<th>Length</th>
<th>Handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 cm</td>
<td>30173 AR</td>
</tr>
<tr>
<td>43 cm</td>
<td>(images of needle holders)</td>
</tr>
</tbody>
</table>

**Single action jaws**

<table>
<thead>
<tr>
<th>Working Insert</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173 R</td>
<td>30173 RAR</td>
</tr>
<tr>
<td>30178 R</td>
<td>30178 RAR</td>
</tr>
</tbody>
</table>

KOH Macro Needle Holder, jaws curved to right, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Working Insert</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173 L</td>
<td>30173 LAR</td>
</tr>
<tr>
<td>30178 L</td>
<td>30178 LAR</td>
</tr>
</tbody>
</table>

KOH Macro Needle Holder, jaws curved to left, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Working Insert</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173 F</td>
<td>30173 FAR</td>
</tr>
<tr>
<td>30178 F</td>
<td>30178 FAR</td>
</tr>
</tbody>
</table>

KOH Macro Needle Holder, straight jaws, with tungsten carbide inserts, for use with suture material size 0/0 – 7/0

<table>
<thead>
<tr>
<th>Working Insert</th>
<th>Complete Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>30173 G</td>
<td>30173 GAR</td>
</tr>
</tbody>
</table>

KOH Macro Assistant Needle Holder, straight jaws
**KOH Macro Needle Holders**

dismantling

**Size 5 mm**

Operating instruments, lengths 33 and 43 cm, with axial handle for use with trocars size 6 mm

<table>
<thead>
<tr>
<th>Length</th>
<th>Handle</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 cm</td>
<td>30173 PR</td>
</tr>
<tr>
<td>43 cm</td>
<td></td>
</tr>
</tbody>
</table>

**Single action jaws**

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</thead>
<tbody>
<tr>
<td>30173 R</td>
<td>30173 RPR</td>
</tr>
<tr>
<td>30178 R</td>
<td>30178 RPR</td>
</tr>
</tbody>
</table>

**KOH Macro Needle Holder**, jaws curved to right, with tungsten carbide inserts, for use with suture material 0/0 – 7/0

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<tr>
<th>Working Insert</th>
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<tr>
<td>30173 L</td>
<td>30173 LPR</td>
</tr>
<tr>
<td>30178 L</td>
<td>30178 LPR</td>
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**KOH Macro Needle Holder**, jaws curved to left, with tungsten carbide inserts, for use with suture material 0/0 – 7/0

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<tr>
<td>30173 F</td>
<td>30173 FPR</td>
</tr>
<tr>
<td>30178 F</td>
<td>30178 FPR</td>
</tr>
</tbody>
</table>

**KOH Macro Needle Holder**, straight jaws, with tungsten carbide inserts, for use with suture material 0/0 – 7/0

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<thead>
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<td>30173 GPR</td>
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**KOH Macro Assistant Needle Holder**, straight jaws
CUSCHIERI Liver Retractor
Size 5 and 10 mm

Multiple puncture approach
Operating instrument, length 36 cm, for use with trocars size 6 mm

Special Features:
- Automatic retraction of the liver for extended periods of time
- Also suitable for simple, atraumatic manipulation of other anatomical structures
- Easy dismantling for cleaning purpose

30623 U CUSCHIERI Retractor, size 5 mm, length 36 cm

30623 UR CUSCHIERI Retractor, size 10 mm, length 36 cm

30623 URL CUSCHIERI Retractor, large contact surface, size 10 mm, length 36 cm
Coagulation and Dissection Electrodes with Suction and Irrigation Channel

37370 DL  Coagulating and Dissecting Electrode, with channel, L-shaped size 5 mm, length 36 cm, for use with suction and irrigation handles

30810  Handle, for suction and irrigation, autoclavable, for use with 5 mm coagulation suction tubes and 3 and 5 mm suction and irrigation tubes

37113 A  Handle, pistol grip, with clamping valve, for suction and irrigation, autoclavable

BERCI Fascial Closure Instrument
for subcutaneous fascial closure

26173 AM  BERCI Fascial Closure Instrument, for subcutaneous ligature of trocar incisions, size 2.8 mm, length 17 cm, for closure of trocar incision wounds
Notes:
Notes: