New Technologies in Liver Laparoscopic Surgery

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Drawbacks of Laparoscopy in Liver Surgery

• No palpation of the liver surface for subcapsular tumor
• More difficult tumoral margin visualization
• Less degree of freedom of laparoscopic instruments
• No palpation of the liver surface for subcapsular tumor
• More difficult tumoral margin visualization
170 patients operated by laparotomy for HCC who had received ICG (0.5 mg/kg) at least 48 hours before liver surgery

Intraop. detection of 21 new spots in 19 patients → 14 HCC (8.2%) and 7 False-Positive

Low specificity in severe cirrhosis
Macroscopic vascular (or duct bile) invasion
Near-Infrared Fluorescence-Guided Resection of Colorectal Liver Metastases

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40 patients operated by laparotomy / Detection of new superficial metastases in 5/40 (12% of patients)

New lesion in 2/30 pts operated for CRLM in Paul Brousse (Unpublished data)
Fluorescent Fusion images on lap normal image
Bile Duct Vizualisation and Anatomical Resection

Injection of 5 mg of ICG at least 3 hours before surgery to enhanced bile duct more than normal liver

Injection of 1.5 mg of ICG during surgery

With the courtesy of T. Ishizawa and M. Terazawa
Applications of fusion-fluorescence imaging using indocyanine green in laparoscopic hepatectomy

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2014 – 2016 : 41 patients with lap hepatectomy using PINPOINT imaging System (NOVADAQ)

Injection of ICG (0.5 mg/kg) within 3 days before surgery and 1.25 mg of ICG during surgery

45/53 malignant tumor (85%) visible on the liver surface prior to hepatectomy

22 were grossly non detectable and visible only with ICG-Fluorescence Imaging

Identification of new met. (Colorectal liver met) in 2/41 (5%)

Modification of Surgical Strategy in these 2 patients
With the courtesy of T. Ishizawa and M. Terasawa
Fluorescence imaging of hepatic tumor

With the courtesy of T. Ishizawa and M. Terasawa
Hepatic transection of the dorsal aspect

With the courtesy of T. Ishizawa and M. Terasawa
5-ALA: Natural Precursor of Heme that could be accumulated in Cancer... Less sensible but more specific than ICG
Arginine-Glycine-Aspartic Acid (RGD) is ligand of tumoral integrin

NanoParticule Loaded with RGD and ICG
gGlu-HMRG was topically applied to 103 freshly resected specimen
Intra-Operative Pathological Analysis

MaunaKea Technology

VizioBot – Confocal MiniProbe

Persee Protocol – IMM

With the courtesy of B. Gayet and D. Fuks
Proof of Concept

After ICG Injection
Real-Time Confocal Laser Endomicroscopic Evaluation of Primary Liver Cancer Based on Human Liver Autofluorescence

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Proof of concept in 6 patients with HCC (n=4) and ICC (n=2)

Low Fluo

HCC

High Fluo

Low Fluo

Heterogenous and Low Fluo

ICC

High Fluo

High Fluo
Potential Drawbacks of Laparoscopy in Liver

• No palpation of the liver surface for subcapsular tumor
• More difficult tumoral margin visualization
• Less degree of freedom of laparoscopic instruments
Robot-like dexterity without computers and motors: a review of hand-held laparoscopic instruments with wrist-like tip articulation

Patrick L. Anderson, Ray A. Lathrop & Robert J. Webster III

Table 1. Summary of articulating laparoscopic instruments.

| Device                  | Kinematic mapping | Wrist type | Handle design | Reusable | Entity producing or developing | Status                                                               |
|-------------------------|-------------------|------------|---------------|----------|--------------------------------|                                                                     |
| RealHand                | Reverse           | Curved     | Pistol        | No       | Novare Surgical Systems, Inc. | Was commercially available, but no longer sold                     |
| Laparo-Angle SILS Hand  | Reverse           | Curved     | Pistol        | No       | Medtronic (previously Covidien) | Commercially available                                               |
| Instrument MiFlex      | Reverse           | Curved     | Pistol/ joystick | Handle: yes End effector: no | DEAM B.V. | Unknown                        |
| Radius Surgical System  | Neither           | Pinned     | Lever/knob    | Yes      | Tuebingen Scientific, GmbH     | Commercially available                                               |
| Maestro                 | Either            | Pinned     | Symmetric-reverse hemostat Forearm mounted | Unknown | Vanderbilt University | Seeking commercial partners                                          |
| FlexDex                 | Parallel          | Pinned     | Pinned        | Unknown  | University of Michigan         | Under development by FlexDex Surgical Inc. Commercial release planned for 2016 |
| DragonFlex              | Parallel          | Pinned     | Symmetric-hemostat/ shaft grip | Pinned | Delft University of Technology | Unknown                                                               |
| Easy Grasp              | Parallel          | Pinned     | Hemostat/ shaft grip | Pinned | Tianjin University | Unknown                                                               |
| Intuitool               | Reverse           | Pinned     | Pisto/trackball | Unknown | University of Nebraska | Seeking commercial partners                                          |
Synergic Robot: Comanipulation or Cobot...

The « Cobot » is manipulated by the surgeon on the surgical field

The cobot knows in real time where is the tip of instrument and could be become resistante to avoid dangerous area of the field

Stabilize the gesture and decreased tremor

Also usefull for stabilization of 3D Camera
Smartphone of the Expert Surgeon... or Pathologist

Streaming

Advices....
The Future of Lap Liver Laparoscopy

• Additionally to Robotic and Intra Operative Enhanced Reality

• Improvement of guided fluorescent liver surgery with new probe
• Microscopic IntraOperative Analysis of margin using Confocal Microscopy
• Potential alternative to Robotic Surgery using Synergic Robot
• Improvement of Intra-Operative Communication
Computer-Brain Interface... wireless in future