1.1 Image-Enhanced Technologies
Improvements of Endoscopic Imaging: Why? (1)

• Detection:
  - minimal color changes
  - minimal relief changes

• Characterization:
  - analysis of superficial vascular network
  - assessment of mucosal pattern
Improvements of Endoscopic Imaging: Why? (2)

Characterization:

- benign without malignant potential => no treatment
- benign with malignant potential => endoscopic treatment
- malignant with invasion limited to mucosa and/or sub mucosa => endoscopic treatment or surgery
- malignant with deep invasion into digestive wall => surgery
Modern Endoscopic Imaging (3)

- High-resolution video endoscopes
- Sequential or color CCD

- NBI (Olympus), BLI, CLI (Fujifilms), OE (Pentax)
- Structure enhancement, FICE, I-Scan

- Optical magnification with Zoom or near focused lens
- Wilder field of view
Narrow Band Imaging (NBI) is designed to improve the CONTRAST of blood vessels & microvascular system vs. surrounding tissue
Summary of NBI Technology

NBI uses two major peaks of light absorption for hemoglobin.
NBI for Color Chip

Simultaneous Illumination with 415 nm & 540 nm
Change Contrast in Luminosity (Brightness)

"But soft! What light through yonder window breaks? It is the East, and Juliet is the sun! Arise, fair sun, and kill the envious moon, who is already sick and pale with grief. That thou hast maid art far more fair than she. "O Romeo, Romeo! Wherefore art thou Romeo? Dost thou deny thy father and refuse thy name? If thou wilt not, be but my love, and I'll be no longer a Capulet."

Change Contrast in Hue (Color)

"But soft! What light through yonder window breaks? It is the East, and Juliet is the sun! Arise, fair sun, and kill the envious moon, who is already sick and pale with grief. That thou hast maid art far more fair than she. "O Romeo, Romeo! Wherefore art thou Romeo? Dost thou deny thy father and refuse thy name? If thou wilt not, be but my love, and I'll be no longer a Capulet."

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(a) Copyright: Y. Sano, S. Yoshida

(b)
Basic principle of NBI

How the image is created

Because of the 2 wavelengths in narrow band light, the contrast in the surface is enhanced, and customers can observe the surface and vascular pattern clearly.

Hemoglobin (blood vessels) absorbs the NBI light and blood vessels are reproduced darkly.

NBI light reaches only the surface of the mucosa.

Hemoglobin (blood vessels) absorbs the NBI light and blood vessels are reproduced darkly.

Only blood vessels in the surface are reproduced darkly, thus enhancing the contrast to the mucosa.
Improved image quality

• **CV-290: Noise Reduction**
  - Noise reduction eliminates noise effectively without image deterioration. The conventional noise reduction function was designed to apply fixed noise reduction effect all the time. However, the new noise reduction function is now designed to apply noise reduction effect according to brightness of image. The result is increased effectiveness in noise reduction.

• **CV-290: AGC (Automatic gain control)**
  - AGC tuning has been adjusted to improve response speed, making the AGC more useful. When moving from a bright area to a dark area, response is now faster, enabling comfortable, stress-free observation.
## Spectrum of potential indications of endoscopy with NBI (1)

<table>
<thead>
<tr>
<th>Site</th>
<th>Endoscopic criteria</th>
<th>Clinical relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous epithelium</td>
<td>Vessels:</td>
<td>Detection + analysis:</td>
</tr>
<tr>
<td>In the esophagus</td>
<td>Intrapapillary capillary loops</td>
<td>superficial neoplasia</td>
</tr>
<tr>
<td>EG region</td>
<td>Surface morphology:</td>
<td>Diagnosis + surveillance:</td>
</tr>
<tr>
<td>Barrett’s Esophagus</td>
<td>Intestinal metaplasia</td>
<td>Barrett’s esophagus</td>
</tr>
<tr>
<td></td>
<td>Superficial neoplasia</td>
<td></td>
</tr>
<tr>
<td>Gastric mucosa:</td>
<td>Surface morphology:</td>
<td>Detection + analysis:</td>
</tr>
<tr>
<td>corpus and antrum</td>
<td>pit pattern</td>
<td>superficial neoplasia</td>
</tr>
<tr>
<td>Vessels:</td>
<td>Capillaries</td>
<td>Detection + analysis:</td>
</tr>
<tr>
<td></td>
<td>Collecting veinules</td>
<td>H pylori infection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chronic gastritis</td>
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</tbody>
</table>
### Spectrum of potential indications of endoscopy with NBI (2)

<table>
<thead>
<tr>
<th>Site relevance</th>
<th>Endoscopic criteria</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duodenal mucosa</strong></td>
<td><strong>Surface morphology:</strong></td>
<td><strong>Diagnosis:</strong></td>
</tr>
<tr>
<td></td>
<td>Atrophy of intestinal villi</td>
<td>Gluten enteropathy</td>
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<table>
<thead>
<tr>
<th><strong>Colonic mucosa</strong></th>
<th><strong>Surface morphology:</strong></th>
<th><strong>Detection + analysis:</strong></th>
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</thead>
<tbody>
<tr>
<td>pit pattern</td>
<td>supficial neoplasia</td>
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<tr>
<td><strong>Vessels:</strong></td>
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<tr>
<td>Capillaries pattern</td>
<td>Ulcerative colitis</td>
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</table>
NBI examples
Barrett Esophagus
Barrett esophagus
gastritis
Sessile serrated adenomas
Colonic polyp
Rectal villous adenomas
NBI with EXERA III
Barrett esophagus
Barrett esophagus

Exera III
Barrett esophagus
Barrett esophagus
Antral carcinoma
Advanced gastric carcinoma
Gastric lymphoma
Colonic polyp
Optical Enhance (OE - Pentax)

• Different from I-Scan

• OPTICAL TECHNOLOGY very similar from NBI or BLI
  - mode 1: blue and green filters (as NBI and BLI)
  - mode 2: enhanced white light for improved detection
Optical Enhance
Optical Enhance mode 1
Optical Enhance mode 2
Optical enhancement
Blue Laser Imaging (BLI - Fujifilm)

• Totally different from FICE

• New optical development
BLI versus FICE
BLI, BLI-bright, FICE

1 Image-Enhanced Technologies
BLI and BLI-bright
BLI with optical magnification

A モード  B モード  色調 1  色調 2
Blue Laser Imaging

<table>
<thead>
<tr>
<th>MV pattern</th>
<th>Regular/Irregular/absent</th>
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<table>
<thead>
<tr>
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<table>
<thead>
<tr>
<th>DL</th>
<th>demarcation +/-(+/-)</th>
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Clinical benefit of NBI and related techniques

- Alternative to traditional chromoscopy

- Endoscopic assessment:
  - mucosal structure (pit pattern classification)
  - vascular superficial network

- Easy to carry on!