Development of Robotic Endoscopic Surgical Platform for Treatment of Early Gastrointestinal Cancers

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Elderly and Healthcare in Hong Kong

**Advanced age**

**High risk for Cancer**

**Multiple Diseases**

**Poor surgical risks**

**Hong Kong’s Ageing Population**

- **Year 2011**
  - Percentage of the population over the age of 65: 13%

- **Year 2041**
  - Percentage of the population over the age of 65: 30%

**Proportion of working population to retirees**

- Each Retiree is supported by 2 working age adults
- Each Retiree is supported by 2 working age adults

**Life Expectancy of Hong Kong People**

- **Men**
  - Age 84.4

- **Women**
  - Age 90.8
Cancers of the GI Tract - Important cause of cancer death in Asia
Gastric cancer – a major problem in China and Asia!

70% of the gastric cancers occurred in Asia!

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.
Prognosis of ca stomach related to stage of the cancer!
Minimally Invasive Surgery

- Improve surgical recovery especially in Elderly
- Reduced pain after operation
- Largely driven by Technological Advancement!
No Scar Surgery?!
No pain, No wound, Even better recovery!
Early GI cancer Treatment options

Local treatment (Minimal risk of LN metastasis)

Loco-regional (high risk of LN metastasis)

EMR / ESD

Minimal access Surgery
Flexible Endoscopic Surgical Resection – Advantages

• Local curative intent treatment

• Organ preservation
  – Function of the organ preserved
  – Better quality of life
  – Less post-gastrectomy syndromes

• Better postoperative outcome
  – Shorter hospital stay
  – Early return of GI function

Chiu PW. GIE 2006
NOTES: Natural Orifices Transluminal Endoscopic Surgery

It is like going to the moon – Difficult, challenging and NOT a daily routine

BUT, NOTES will lead to innovation and development of important technologies that can be applied for daily clinical practice
The first proposal of submucosal tunneling

- For safe peritoneal access in NOTES

Sumiyama K et al GIE 2007
Per Oral Endoscopic Myotomy vs Robotic

Robotic Surgery with 5 abdominal incisions

Endoscopic Surgery without any incision

Inoue H et al Endoscopy 2010; Chiu PW et al GI Endoscopy 2013
Development of Endoscopic Surgery is limited by design of the endoscope

• Endoscopy was initially designed for diagnosis

• Future endoscopes will be designed as a multi-tasking platform allowing complex surgical tasks to be performed
Mechanical Endoscopic Multi-tasking platforms

Achieve surgical tasks in a confined gastrointestinal lumen
Limitation in pure mechanical design – limitation in force translation
Developed by Industries!

EndoSAMURAI (Olympus)

DDES
Direct Drive Endoscopic System
(Boston Scientific)

Cobra (USGI)
Endo-Samurai®

Courtesy from Dr K Ikeda, Jikei University
Development of Robotic Endoscopy

Robotic Endoscope
Multi-Tasking

Robotic enhanced endoscopic platform
Task Specific
Design Concept

1. Be able to enter through mouth/anus (Flexible access)
2. Be able to effectively push the tool forward (Rigid backbone)
3. Be able to work in a confined workspace (Flexible structure)
4. With precise tooltip control (Rigid link)
CUHK Robotic Endoscopic platform
Major Milestones Up-to-Date

Preclinical/Clinical

Engineering

2013

V1                        V2                                V3                      V4                  V5                  V6            V7

Continuum Structure       Mapped Master Console    Design by 3D Printing    Translation Mechanism

Precision and Response Time Analysis, Miniaturization

To-date
System Overview

Robot Arms

Controller

Driven Unit

Computer
Robot arms

USGI “TransPort”

- Overtube
- Translation Guiding Disk
- Disk
- SMA
- Continuum Section
- Electric Knife
- Lifter
- Dissector
- Hinge Joint
- Gripper
Ex-vivo porcine model setup for gastric ESD
Ex-vivo porcine stomach ESD model
Ex-vivo porcine stomach ESD model
Ex-vivo porcine stomach
ESD_expert vs novice

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GIS= Gastrointestinal surgeon; RE= Robotic Engineer; GIRA= Gastrointestinal Research Assistant; EN= Endoscopy Nurse
Ex-vivo porcine stomach
ESD_expert vs novice
Research plan

• In-vitro porcine gastric ESD using the CUHK Robotic Endoscopic platform

• Prospective clinical trial using the Robotic Endoscopic platform for performance of resection for early gastric cancer
Acknowledgements

**Engineering Team**
- Prof Carmen Poon
- Prof Y Yam (MAE)
- Dr H Tong (MAE)
- Lau Ka Chun (PhD student)
- Billy Leung
- Cecilia Chan

**Clinical Team**
- Prof James Lau
- Prof Enders Ng
- Dr Simon Wong
- Dr Anthony Teoh
- Dr Raymond Tang
- Dr Shirley Liu
- Endoscopy Nurses

**Industrial Sponsors for ITF Tier 2 application**
- Innovation and Technology Commission
- Olympus
- Soon Luck Industrial Ltd.
- MediConcepts

Faculty of Medicine
The Chinese University of Hong Kong