Development of Robotic Platform for Gastrointestinal ESD

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Introduction

Gastrointestinal cancers remain the commonest cause of cancer mortality worldwide [1]. Gastric cancer remained the second commonest cancer while there is a rapid increase in incidence of colorectal cancer in both Asia and the West. Advance stage gastrointestinal cancers carried grave prognosis, while early gastrointestinal cancers carried excellent 5 year survival of more than 80% [2]. Currently, endoscopic resection is the standard for treatment of early GI cancers with minimal risk of lymph node metastasis. The development of endoscopic submucosal dissection (ESD) allowed en-bloc resection for early GI cancers and significantly reduced the risk of local recurrence [2]. ESD, however, is difficult to master as it required endoscopic dissection performed through a coordinated movement between the ESD device and the endoscope. In one of our training workshops for ESD, experienced endoscopists enrolled to perform their first ESD resulted in 62% of perforation [3]. One of the major difficulties for performance of ESD is the coaxial alignment of the ESD device with the endoscope, and the lack of retraction to improve visualization of the submucosa. In collaboration with clinicians and engineers from National University of Singapore and Nanyang Technological University, we developed a robotic endoscopic platform for performance of endoscopic resection using two robotic arms [4].

Method and Results

The first generation robotic endoscopic platform (Master And Slave Transluminal Endoscopic Robot (MASTER)) was developed with preclinical experiments to confirm the efficacy and safety [5]. In comparison with conventional ESD using IT knife, the MASTER robotic endoscope achieved significantly shorter time for performance of gastric ESD. The first multicenter cohort study on performance of MASTER ESD for treatment of early gastric neoplasia was conducted in Hyderabad and Hong Kong in 2011. Five patients received MASTER endoscopic ESD with the operative time varied between 26 minutes to 68 minutes. All the ESD procedures were completed safely without complication.

With a view to investigate the enhancement in learning curve for ESD with MASTER, we conducted a preclinical study to compare the performance of ESD between experts and novice [6]. A pre-defined 2cm gastric mucosal lesion was first marked by an independent endoscopist. Afterwards, we invited a group of experts in
endoscopy to perform ESD using MASTER for each of the lesions. The second group of novice included engineers who had no experience in endoscopy or ESD to perform ESD using MASTER for the pre-defined lesions. The results demonstrated that there was no difference between novice and endoscopists in the time to first grasp the mucosa by MASTER, time for completion of the procedure and time for submucosal dissection.

There are limitations in the design of first generation MASTER. Hence the next phase of development for the second generation MASTER focused on improvement in the endoscopic platform and the control of the robotic arms to enhance the performance of endoscopic resection. We have already successfully conducted in vivo animal experiments on performance of esophageal and colonic ESD using the 2nd generation MASTER. In the future, MASTER will be able to perform complex endoluminal surgical tasks like endoscopic full thickness resection [7].

Conclusions

MASTER robotic endoscopic platform represents a major breakthrough in therapeutic endoscopy. The robotic system greatly enhanced performance of ESD, as well as complex endoluminal surgical procedures in the future.

References