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MEDICAL CONNECT

Robotic liver surgery

Article 1

Dr Lee Ser Yee

Senior Consultant Hepatopancreatobiliary Surgeon
MBBS, MMed (Surgery), MSc, FAMS, FRCSEd, FACS

Surgical Associates
Suite 08-07, Mount Elizabeth Medical Centre
3 Mount Elizabeth, Singapore 228510
www.surgicalassociates.sg

Dr. Lee Ser Yee specializes in Hepatopancreatobiliary surgery (HPB), Liver transplantation, Minimally-Invasive Surgery. His area of expertise lies in minimally invasive techniques such as laparoscopic and robotic surgery in the treatment of liver, gallbladder and pancreas diseases and cancers.

Prior to private practice, he was a founding member and Senior Consultant at the Department of Hepatopancreatobiliary (HPB) and Transplant Surgery at Singapore General Hospital (SGH) and an Associate Professor with the Duke–NUS medical school. He served as the Director of the Laparoscopic program and the Director of the Surgical Skills Training Program at the SingHealth Surgical Skills Centre.

He completed his training in General Surgery, HPB surgery and Liver Transplantation at SGH and National Cancer Centre, Singapore. He also completed dual USA fellowships in Advanced Laparoscopic HPB surgery and Liver Transplantation at the New York Presbyterian Hospital-Weill Cornell Medical Center and a Complex Surgical Oncology clinical fellowship at Memorial Sloan Kettering Cancer Center in New York.

He has authored more than 180 scientific publications, 2 surgical books and over 70 book chapters and sits on the Editorial and Reviewer Board for more than 30 international medical journals. He also serves in the committees of the International HPB Association (IHPBA), the Chapter of General Surgeons, Singapore and is the current Vice-president of the Singapore HPB Association.

Dr. Lee Ser Yee is a pioneer and an international key-opinion leader in the use of novel fluorescence imaged-guided surgical techniques for liver surgery and has special interest in colorectal liver metastases.

Minimally invasive liver surgery is the foremost frontier in the evolution of hepatobiliary surgical techniques. Besides conventional laparoscopic techniques, the surgical robot has provided another new tool in the surgical armamentarium to elevate the standard of care of patients.

Case Study

A 63 years old gentleman presented with per-rectal bleeding and upon evaluation, it was found to be due to a colorectal cancer and it has metastasized to the liver and the lungs. Due to the synchronous presentation and the significant disease burden, upfront systemic therapy was initiated. After 6 cycles of chemotherapy, the restaging scans revealed good treatment response and he was referred to our team for assessment for suitability for surgery.

After a multi-disciplinary discussion and review, it was deemed that a minimally-invasive simultaneous liver and colorectal resection in a single stage and setting is possible and potentially beneficial for the patient. He was initiated on the Enhanced Recovery after Surgery (ERAS®) protocol to optimise his pre-operative fitness, such as incentive spirometry training and nutritional supplementation.

A combined simultaneous robotic liver and colorectal resection was performed in Mount Elizabeth Novena Hospital with the new da Vinci Xi system. The robotic liver resection was aided by the firefly system that allows intra-operative near-infrared (NIR) imaging for tumor localisation with indocyanine green (ICG). In selected cases, a fluorescent dye (ICG) is administered to the patient a few days prior to the surgery so that during the surgery, a special camera with NIR capability will detect the tumours in the liver as the fluorescence dye is retained in and around the tumours but not in the normal liver. This aids in the identification of the tumours as it glows green (Figure 1). This, in addition to the use of concurrent intra-operative ultrasound, which can be also easily handled with the aid of the dexterous robotic “hands”, enables a picture-in-picture view that further improves the precision of the surgery, such as the depth and width of the resection required for adequate margins in cancer surgery. (Figure 2)

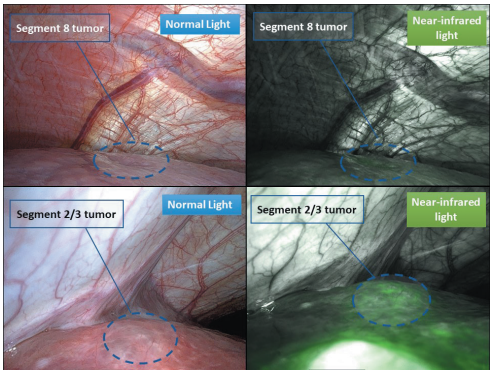

Figure 1

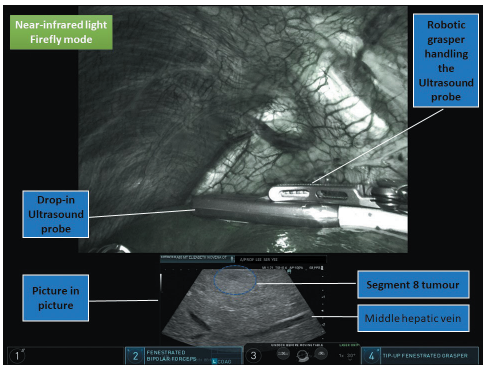

Figure 2

Medical Connect is a bi-monthly newsletter that is published with the support of an educational grant by Eisai (Singapore) Pte Ltd. Medical Connect serves to provide practicing medical doctors in Singapore with updated information on diseases as well as their management. Medical Connect will cover topics in gastroenterology, neurology, psychiatry, oncology, geriatric and various other fields. For more information, please send request to g-lim@eisai.com.sg.

The combined surgery was uneventful and both liver and colorectal teams managed to complete the surgery robotically (Figure 3). Patient recovered uneventfully and was discharged on the 7th post-operative day. Soon after, the patient had another minimally invasive surgery (MIS) lung resection and is due to continue and complete the rest of the chemotherapy regime without a long interval or delay between the surgeries and systemic treatment.

Discussion

The liver is the most common place for colorectal cancer metastasis because of the portal circulation draining all blood flow from the gastrointestinal tract. Colorectal cancer remains one of the most common reasons for liver resection in patients with metastatic disease. About half of the patients with colorectal cancer will develop liver metastasis during the course of their disease and up to 30% of patients may present with synchronous colorectal liver metastasis. The surgical intervention for patients with colorectal cancer with synchronous metastasis to the liver has evolved in tandem with improved techniques, expertise, experience and advances in technology over the years. Studies have shown that the simultaneous resection of a colorectal cancer with liver metastases have similar, if not better outcomes compared to the traditional staged approach where morbidity, mortality, and long-term survival outcomes are concerned. The advantages of MIS include less post-operative pain, quicker recovery, shorter hospital day and less physiological disturbance resulting in several benefits - especially in metastatic colon cancer patients, who can embark on the next stage of treatment sooner with a faster recovery, as illustrated in this case, Additional benefits include fewer wound-related complications such as hernia, wound infection and intra-abdominal adhesions, of which the latter is especially beneficial for those that may require future repeat liver resection in cases of new liver metastases.

The traditional paradigm of staged operations for colorectal cancer with liver metastasis has been re-evaluated due to the decrease in morbidity and mortality associated with liver surgeries over the last decades along with the improved efficacy of modern chemotherapy regimes. There has also been a generational shift to less invasive procedures when performing abdominal surgery. Laparoscopic approaches that have been increasingly used for simultaneous procedures. However, there is tardiness in adopting this strategy for colorectal cancer with liver metastases because of the technical challenges and therefore not widely adopted, especially in multi-visceral resections. Some of these technical limitations hindering the simultaneous strategy could be overcome by utilizing a robotic approach.

The one-stage approach avoids two or more separate operations, reducing the risk for the patient, the need for additional general anaesthesia, decreasing time between treatments, as well as the overall costs. Robotic surgery is gaining traction in various fields that require more complex surgical procedures because it allows dissection in confined spaces, improving the surgeons' capability. The da Vinci surgical system has been used for more than 7 million MIS procedures in various subspecialties since its first launch in 1998. The latest system Xi is the fourth-generation system, which is modular and more adaptable, when compared with the previous generation (Si). With slimmer boom mounted arms, extended instrument reach, guided targeting and the camera being able to go into any 8 mm port, the Xi was designed to facilitate use for multi-quadrant surgery, as seen here. The application of robotic technology allows for the performance of liver resections and multi-organ by multi-disciplinary teams in a minimally invasive manner.

The 3-dimensional(3D), high-definition (HD) camera system provides a wide field, magnified, clear and stable in-console view of the surgical field without the need for 3D polarised glasses which are required in the laparoscopic 3D camera systems, decreasing the surgeons' visual fatigue. The depth of perception provided with the 3D optics are particularly useful in liver surgery when we cut into the depths of the liver parenchyma. The dexterity and a slimer profile and footprint of the Xi system also provides much needed space for the bedside assistant surgeon and scrub team to assist in the surgery. The advanced instruments include advanced energy devices further augments many aspects of the technical challenges associated with laparoscopic liver surgery. The robotic arms are highly dexterous, with tiny wristed instruments that can bend with 7 degrees of freedom and rotate 360 degrees. The robot also never tires and are highly stable and tremor-free. During robotic surgery, the primary surgeon sits at the robotic console ergonomically to manipulate the system's controls to perform the surgery, the console translates the surgeon's movements into the robotic arms to which tiny operating "hands" and camera are attached for performing the surgery.

The latest generation of the da Vinci Xi system (Xi) allows ease of multi-quadrant surgery as the boom-mounted arms with multi-position set up joints are designed to help maximize the surgical workspace externally and internally, this and the advanced set-up guidance is particularly useful in this combined liver and colorectal surgery as it allows the teams to operate effectively in different areas, e.g. the upper abdomen and the pelvis without the need for redocking and resetting up, reducing operative time and the need for additional incisions. (Figure 4)

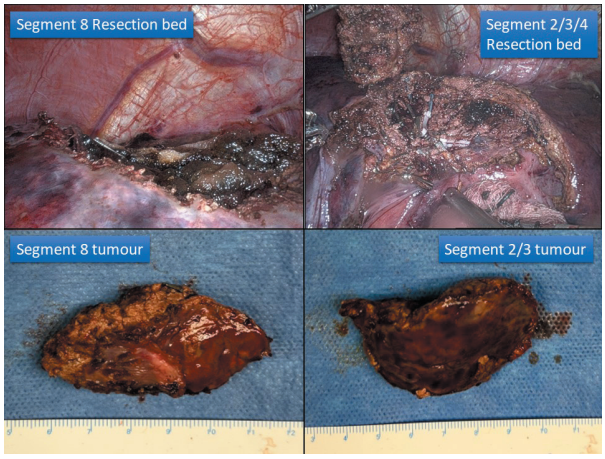

Figure 3

Figure 4

Robotic surgery has been in use for over 20 years but in the field of Hepato-pancreato-biliary procedures, it is still in its infancy. At current state, robotic liver surgery cannot yet replace laparoscopic surgery as there are still many aspects in which the robotic platform has to improve upon, but the latest generation is certainly moving in the right direction to augment laparoscopic surgery. The high cost of robotic surgical systems has been a big reason for the sluggish acceptance of robotic-assisted surgery worldwide. Most hospitals in Singapore have only one system, which is shared by all specialties. With more robotic systems entering the market as the current dominant patents expire, the cost is expected to drop. Likewise, opportunities to learn robotic-assisted skills will increase greatly with improved accessibility to the next generation of surgeons. Hopefully, in time, this will translate to better and more affordable patient care.

Acknowledgements

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