EDITORIAL

ROBOTIC HEPATOBILIARY AND PANCREATIC SURGERY

Robotic surgery is minimally invasive interventions performed with the help of a surgical robot. Instead of the surgeon directly holding surgical instruments, robotic arms hold the specifically designed keyhole instruments; the surgeon then takes full control of the robot and moves them through a console using joysticks. The robotic instruments are agile and offer 7° of freedom so that the surgeon can easily access complex and oddly located pathologies precisely. It is worth mentioning that the human arm although more dexterous also has seven degrees of freedom; therefore, the robotic surgery offers the freedom of movements of a human arm in a minimally invasive environment. The three-dimensional (3D) view of the robotic console improves surgeon's perception of operative field and offers superior assessment of index pathology with the advantage that the robotic arm can operate in the micrometre range much more precisely than the actual surgeon can.

Robotic surgery has been around for nearly 30 years now. The first documented procedure performed with robotic assistance was in 1985 when brain biopsies were taken using PUMA surgical robot. Since then, the robotic surgery has grown leaps and bounds. The first Robotic cholecystectomy was performed in 1987 and transurethral resection of the prostate in 1988. The US government was more interested in the use of surgical robot in NASA and the U.S. Army-Mobile Advanced Surgical Hospital missions. The idea was that a specialist surgeon could remotely operate on a patient in space or battlefield. Working on this theme, a trans-Atlantic cholecystectomy was performed by a surgeon in the US on a patient in France. The procedure went well, but the hands across the oceans[1] approach could not get widespread acceptance.

In 2000, the da Vinci® became the first surgical robotic system approved by the FDA for general laparoscopic surgery. This initiated beginning of the ever more exciting robotic surgery era. At present, almost all surgical specialties have and are performing robotic surgery to some extent. Urology has taken a lead on this, and due to superior nerve sparing and preservation of function, robotic radical prostatectomy has become the standard of care in certain places.[2]

Hence, what are the advantages and disadvantages of robotic surgery?

There is no doubt that robotic approach provides a better solution for the technical limitations of the conventional minimally invasive techniques. Robotic arms allow increased range of movements and due to their wristed character, robotic instruments offer extended freedom as compared to laparoscopic instruments. The robot can filter physiologic tremors, increases ergonomics, and offers unmatched 3D view of the surgical field. It has been shown that robotic approach helps provide higher level of precision, a superior 3D visualisation with better assessment of tissue depth, and improve dexterity compared to the conventional laparoscopic technique.[3]

The main disadvantage of robotic surgery is its cost. Surgical robot is expansive to buy and costs between 1.5 and 2 million pounds. Moreover, the robotic instruments are expansive to use. For example, robotic monopolar hook costs £1750 and can be used 10 times only. Moreover, there is no haptic feedback while operating through the console, the surgeon has to work using the visual feedback only and this requires time and training to develop. It is not difficult to lose sight of additional robotic arms in the surgical field which, in turn, can cause unseen damage outside the view of the surgeon. Therefore, a structured and modular training is required before one can start using the surgical robot on patients.

Robotic training systems are developing and Intuitive® who owns and market da Vinci® robot have come up with a training pathway in the UK which starts with orientation module followed by 30 h of training on the simulator. This then leads on to an online module and assessment that must be passed. A one-to-one service module is then undertaken with Intuitive® representative following which the trainee surgeon is taken to a wet laboratory for training

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on live animal. Surgeon has to pass the assessment at the animal laboratory and will then be taken to a cadaver laboratory for dissection and experience on human body. Trainee surgeon is also taken for case observations at units that perform robotic surgery regularly and also to give him the opportunity to choose a mentor and proctor. After passing all the assessment and approval from hospital clinical governance, ethical, safety, and finance committees, robotic surgery can be undertaken on eligible patients. Initially, all cases are performed while a proctor is present within the theatres. The role of the proctor is to advise on the set up of surgical robot and offer guidance and help during the procedure as needed. The proctor has to write an assessment report on the surgeon's level of skills and safe use of the robot and can sign him off to undertake the procedure independently.

The role of robotic surgery in hepatobiliary and pancreatic surgery (HPB) as a superspecialty is developing. At present, very few surgeons in the world perform complex operations on liver, pancreas, and bile duct with robotic assistance. In the UK, robotic HPB surgeons can be counted on the fingers of one hand.

University Hospital Coventry and Warwickshire NHS Trust started their robotic HPB surgery program at in April 2018. We started with some cholecystectomies to learn setting up the robot and understand its philosophy and working. Since then, we have performed over 50 cases including Whipple's procedure, distal pancreatectomy with and without spleen preservation, splenectomy, excision of extrahepatic biliary tree with Roux-en-Y reconstruction, right hepatectomy, left hepatectomy, left lateral sectionectomy, and atypical liver resections. We have had no mortalities and our morbidity rates are well below that of both open and laparoscopic approach. We plan to publish our detailed results in near future.

The advantages of robotic pancreatic surgery are various. Precise dissection, ease of suturing, control of pedicles, and access to difficult pathology are only to name a few.[4] In our opinion, one of the most important advantage, for example, of robotic Whipple's as compared to laparoscopic Whipple's is that the surgeon is sitting on a chair while working on the console, the camera is held by the robot and this long robotic procedure (8–10 h at our hospital) can be completed in a pleasant environment without surgeon or assistant fatigue. We know many of our HPB colleagues dread laparoscopic Whipple's as it is physically challenging for both the surgeon and assistant. Robotic assistance will ensure longevity of a surgeon's professional career and he can go on to perform long and complex procedures while he gracefully gets older and hopefully wiser while working for the best interest of his patients.

Advantage of robotics in liver surgery can be explained by the fact that it provides the operating surgeon ability to dissect and suture precisely in small difficult to reach locations such as the posterosuperior segments of the liver (Segment VII and VIII). Robotic technique facilitates curved transection lines, thus allows more complex resections to be done minimally invasively.[5] It must be acknowledged that at present we do not have an ideal tool for parenchymal transection in either laparoscopic or robotic surgery. Cavitron Ultrasonic Surgical Aspirator (CUSA) is the gold standard for liver parenchymal transection as it offers superior dissection of Glissonian pedicles with precise control and lower blood loss. The laparoscopic CUSA is available but due to distant fulcrum at the laparoscopic port sites, is not precise, and is difficult to use. There is no equivalent instrument in robotic surgery at present. Parenchymal transection during robotic surgery is undertaken with either a non-wristed Harmonic® or wristed da Vinci® Vessel sealer which is bulky and does not offer CUSA equivalent parenchymal transection. Usually, the surgeon has to make do with monopolar scissors and bipolar fenestrated graspers.

In summary, robotic surgery is an exciting development and makes minimally invasive surgery possible in otherwise challenging cases. The cost of robotic surgery has limited its widespread use in the world. With the development of new robotic systems (e.g., Google-Ethicon surgical robot), the economics of robotic surgery is likely to improve. Robotic HPB is challenging but extremely rewarding and with emerging evidence will secure its place in most operating theatres.

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References

1. Kent H. Hands across the ocean for world's first trans-atlantic surgery. CMAJ 2001;165:1374.
2. Laviana AA, Williams SB, King ED, *et al*. Robot assisted radical prostatectomy: The new standard? Minerva Urol Nefrol 2015;67:47-53.
3. Leal Ghezzi T, Campos Corleta O. 30 years of robotic surgery. World J Surg 2016;40:2550-7.
4. Kornaropoulos M, Moris D, Beal EW, *et al.* Total robotic pancreaticoduodenectomy: A systematic review of the literature. Surg Endosc 2017;31:4382-92.
5. Giulianotti PC, Bianco FM, Daskalaki D, *et al.* Robotic liver surgery: Technical aspects and review of the literature. Hepatobiliary Surg Nutr 2016;5:311-21.