Robotic surgery for cancer

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Robotic surgery was developed for the first time in the 1990s. The first group focusing upon this development was the Research Center in Karlsruhe, Germany and the Section for Minimally Invasive Surgery in Tuebingen, Germany. Further work was performed in the United States that ended in the development of an industrial produced system called Zeus and another system produced by Intuitive Surgery (Fig. 1).

The aim to develop robotic systems was first realised to integrate degrees of freedom into the application of endoscopic surgery that allowed more precise dissection and specifically more precise suturing in cases of anastomosis.

Clinical application of robotics in general surgery could demonstrate the following results:

- Advantages for the surgeon could be clearly documented in the area of better degrees of freedom which results in more precise suturing.
- From the ergonomical standpoint the working conditions on the console has proven to be much more convenient with less negative problems for the posture of the surgeon.
- The stereoscopic vision provided for the surgeon on the console was demonstrated to be superior to any other 3-D-technology available up to this time.

Fig. 1. Robotic system ' da Vinci Surgical System' by Intuitive Surgical. Disadvantages in general have been proven to be the highly complex technology, the high cost of this technology per operation and a time-loss which was documented in most cases compared to classic laparoscopic surgery. However in the area of clinical application of laparoscopic surgery for the visceral surgeon, it was not proven objectively that the clinical outcome was positively influenced by application of robotics.

Experience with a manual manipulator

The aspect of more degrees of freedom for more precise application of endoscopic surgery can also be followed up by the use of a mechanical control system with all degrees of freedom which can be called manual manipulator.

We have developed together with the company Tuebingen Scientific Surgical Products GmbH a manual manipulator called Radius System, which provides similar possibilities concerning degrees of freedom as a robotic system. (Fig. 2)

Fig. 2. Manual manipulator ' Radius Surgical System' by Tuebingen Scientific Surgical Products GmbH.

The role of robotic surgery for cancer

In the area of visceral surgery the application of robotics has not proven to be superior to conventional laparoscopic surgery.

Cancer surgery is in most cases extensive surgery including removal of organs and removal of lymph node blocks. This sort of surgery normally needs a wide operative field, the optimal handling of which is not possible with robotic technology. This is due to the dependence of instrumentation orientation that leads to mechanical conflicts such that ports must be changed during the operation leading to a highly complex procedure. This problem is specifically extensive in laparoscopic surgery of the colon as during removal of the left colon the direction of surgical work has sometimes to be orientated towards the spleen and towards the deep pelvis during other parts of the operation.

Robotic surgery in radical prostatectomy

The only area where robotic surgery has proven certain advantages and where some hospitals are focusing on the application of robotics is the removal is the prostate cancer. Some specific points explaining this solution:

- The operative field in the deep pelvis is relatively limited
- The position in conventional laparoscopic surgery is unergonomic
- The anastomosis of the urethra to the bladder is rather difficult using conventional laparoscopic techniques. The application of robotics in this field gives more precise application of the suture and it is possible that with increasing experience the outcome in this operation might be better also.

First experimental trials have also proven that the suture of the urethra to the bladder by the use of the manual manipulator gives more precise sutures and better result for the anastomosis.

Future options of robotics

Robotics in visceral surgery

Next generations of robotics should be much smaller, easier to position and allow more flexibility concerning the area of the operative field which can be reached. It can therefore be foreseen that in the future the application of robotics for cancer surgery has to be redefined.

Application of robotics in transanal endoscopic microsurgery (TEM)

TEM is a rather complex operation which needs precise manipulation. The parallel orientation of the instruments and the very small space, the application of robotic systems or specific manual manipulators will allow more precise and ergonomic suturing and dissection.

To achieve this goal, it is mandatory to have a specific development for endoluminal surgery so that this clinical goal will be possible to achieve within the next few years.

Conclusions

Robotic surgery in cancer has only one application where advantages are proven concerning ergonomics and better view. Actual literature does not demonstrate yet that clinical outcome by application of robotics is better in this field but it can be foreseen that with increasing experience and better technology this can soon be demonstrated.