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Special Article

Innovation-driven Surgery

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Abstract Being a good surgeon, we are trained to have "Eagle's eyes, Lady's hands and Lion's heart" but we also realize well the limitation of human skills and capability as well as human error. The world rapidly progresses with more knowledge and new technologies. Yet, we should recognize that the opportunity and challenges of innovation will pave way for the advancement of surgery: pre-operative investigation, precise diagnosis and evaluation of pathological lesions, accurate operative technique, and hence improve the outcome of surgical treatment for our patients.

Keywords: Innovation, Advanced surgery

New Technologies and Innovations for the Enhancement of Human Vision "Eagle's eyes"

Pre-operative Innovation as "magical eyeglasses"

Looking back into the past, discovery of the X-rays and then contrast radiography led to ever more accurate pre-operative diagnosis than clinical assessment. Ultrasonography was introduced later and proven to be very effective for some specific organs and lesions especially for the differentiation of solid and cystic lesions. Its value for the diagnosis of gallstones, ovarian lesions and many other lesions is undoubtedly very high. New on-top adaptive technologies, i.e., thermal and vascular flow measurement, for example, has been used for the precised diagnosis of some highly vascularized pathologies.

Computed tomography - CT scan and the recently introduced Magnetic Resonance Imaging - MRI have enhanced the human vision such that one can even look through the body's coverings into the visceral organs and

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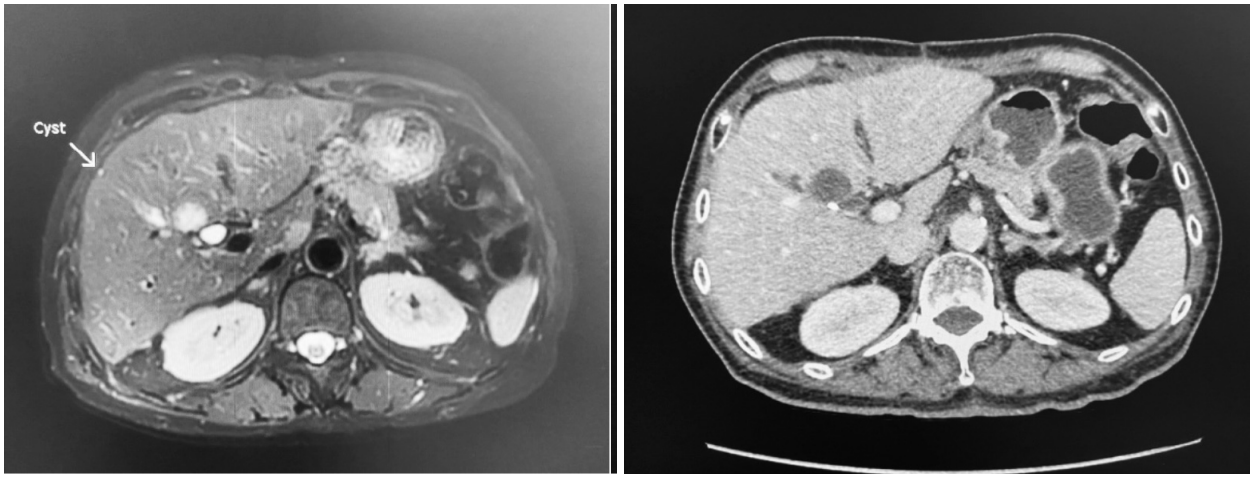

Figure 1 MRI and enhanced-MRI give more details of the lesions in the liver.

abnormalities inside the body. Three-dimensional images can be constructed so that more details of a malignant tumor, such as its extension, the adherence to near-by vital structures and main vessels, or invasion of lymph nodes, can be demonstrated and is very helpful for surgical planning, as well informing the surgical approach and resection technique (Figure 1).

Intra-operative Enhancement of the surgeon's vision

Even though human vision is the best, better than any other technology, operating on a very small, tiny structure or in the infants or neonates whose organs and structures are very small, is difficult based on the human surgeon's unassisted eyesight. Surgical loupe and surgical microscope (Figure 2-3) significantly improve the surgeon's approach when operating in the field of pediatric surgery, neurosurgery, vascular surgery and many other fields including ophthalmology and oto-rhino-laryngology.

Laparoscopy is also one of the newly introduced technology to enhance human vision through the scope.

Limitations of these microscopic and laparoscopic enhanced-vision technology include the 2-dimensional and small size of the visual field (Figure 4).

Thus, innovation needed is in 3-dimension vision technology, which now looks very promising (Figure 5-6).

Intra-operative contrast radiography, ultrasonography, stereotactic instruments and other devices are designed to enhance the surgeon's vision during operations for the identification of pathological lesions, important structures, specific abnormalities and also for the meticulous dissection including the avoidance of injury to critical structures.

Figure 2 Surgeon uses surgical loupes for 2-5 times magnification of the surgical field.

Figure 3 Surgical microscope is used for neuro-vascular and intraocular surgery.*
*Medical imaging solutions - pro.sony-Asia.com/medical2017

The quality of surgical field illumination is one factor for better vision. Many new technologies have been introduced, for example, the prismatic design for shadowless lighting, intense and brighter but heatless light which has proved to enhance the surgeon's vision. The headlight is another adaptative instrument; and fiberoptic light designed to illuminate the far-away surgical field at the tip of the scope is also one of the more valuable innovations (Figure 7-8).

Figure 4 Laparoscopic surgery

Figure 5 Upcoming 3-Dimension and Virtual reality in a new version of laparoscopic surgery (Sony 3D head mounted display system)*
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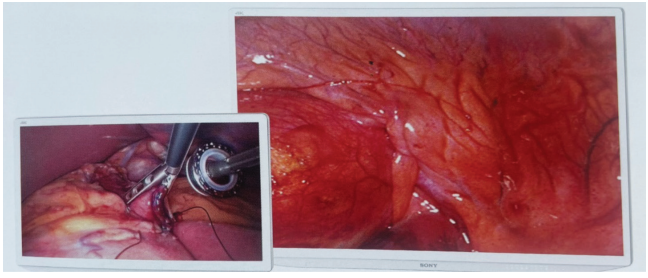

Figure 6 3-D image obtained from laparoscope (4K LCD Sony Surgical Monitor)*
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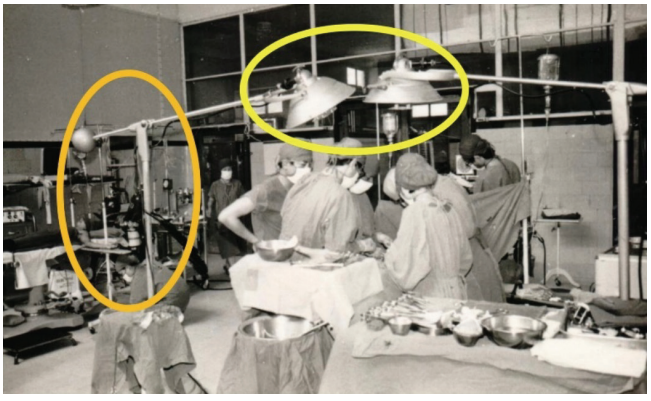

Figure 7 Poor illumination from old lighting technology

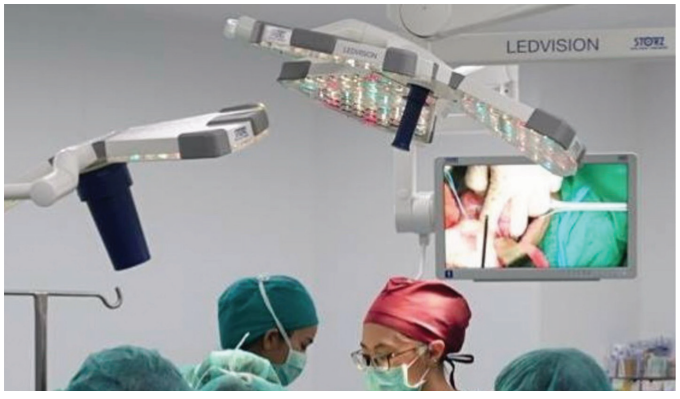

Figure 8 New technology for bright and shadowless surgical illumination

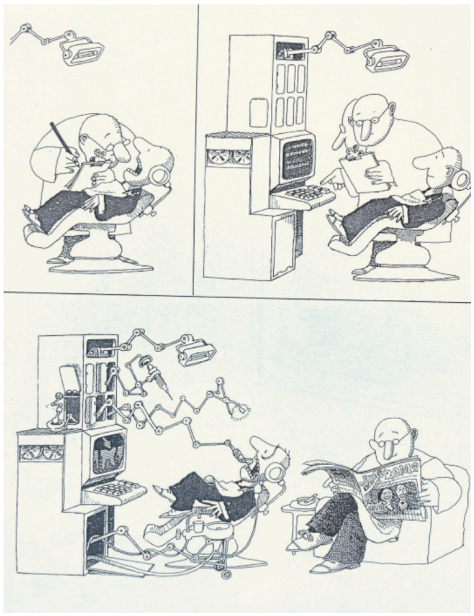

Figure 9 Cartoon from “Quinopterapia” drawn by “Quino” more than 30 years ago showing the idea of robotic surgery.

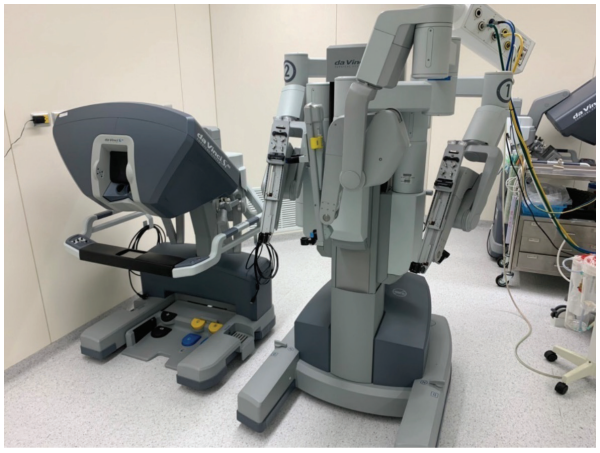

Figure 10 Davinci-Robotic Surgery is now introduced for the prostatic surgery and operation in the limited approached area.

New Technologies and Innovations for the Enhancement of Human Surgical Skills to have more than "Lady's Hands"

Most surgeons face the difficulties when operating in a limited surgical field such as in the pelvic cavity, retrovesical space or mediastinum, requiring new technology to enhance surgical skills and precise dissection. Monopolar and bipolar electro-cautery are very useful and used as basic techniques for hemostasis. Carbon dioxide CO_2 laser is used for bloodless incisions and excisions. Ultrasonic dissection (CUSA) is well-suited for liver and brain dissections, resulting in less bleeding during dissection and less tissue trama.

A more recent innovation is the robotic control of the instruments; it offers not only accurate direction and depth of dissection but also more precise movement of the robotic-control than human-control (Figure 9-10).

New Technologies and Innovations for the Enhancement of Surgeon's Decision

With the rapid advancement of computers, information technology, data science and artificial intelligence, scientists hope that these advanced and integrative technologies will lead to the accurate "Decision Support System" which will enable the surgeon to make optimal decisions for their patients with the best treatment outcome. Such innovations strengthen the "Lion's heart" of the surgeons.

How can the Innovation Drive the Advancement of Surgery?

To be a good surgeon, one must not only learn how the advanced technologies and innovations can help improve the surgeon’s abilities, but one also need to have creativity, problem-solving skills and be a team-player in order to introduce such ideas to scientists, engineers and innovators. This will ensure that the innovations created will serve our needs and if necessary, we should be able to work together to ensure further refinement and finally, to create the best solutions and products.

Conclusion

This article aims to present the advancement of new technologies and innovations which can enable better, more accurate and precise surgical treatments. Such innovations require knowledge from many disciplines; physics, chemistry, biochemistry, material science, electronics, information technology, engineering and also many others. The author also hopes that this article will motivate our surgeons not only to use the innovations but also to innovate and/or to cooperate for innovations.

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