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Three-dimensional laparoscopy: a step toward advanced surgical navigation

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We read with interest the study comparing three-dimensional (3D) and 2D laparoscopy, recently published in *Surgical Endoscopy* [1]. Storz and colleagues [1] showed that a 3D high-definition (HD) system was superior to a 2D HD video system. This intuitive concept is unfortunately only poorly reported to date, but it opens very exciting roads.

Since the introduction of laparoscopy almost 30 years ago, the surgeon has been confronted notably with the loss of binocular vision and a reduction in dexterity [2]. Although the implementation of minimally invasive surgery has gained acceptance in all surgical fields, the drawbacks of laparoscopy are real and explain, at least in part, the technical difficulty for advanced and complex procedures such as liver and pancreatic resections. To overcome these limitations, robotics has been proposed and adopted by many groups, especially for complex cases in which laparoscopy clearly has failed to establish itself as the gold standard [3]. However, the robotic technology, while bringing 3D vision and enhanced instrumentation with endo-wristed technology, has limits as well, including cost, size, and restriction for multiquadrant surgery.

In the meantime, 3D screens have been developed and tested for conventional laparoscopy. However, the interest has been moderate, probably because the real benefices of this new equipment have been only poorly reported. In addition, the quality of the first screens was limited, and the eyestrain was higher than expected.

We recently performed two procedures using a prototype of the 3D screen and endoscope (3D System; Karl Storz, Tuttlingen, Germany). An exploratory laparoscopy (Fig. 1) and a cholecystectomy (Fig. 2) were performed successfully using this new system. We were able to appreciate the comfort of glasses that did not impair vision if we looked away from the screen. Depth perception was perceived without eyestrain, and thus the vision was increased and spatial navigation facilitated.

If subjective elements are clearly in favor of the 3D technology, objective data have lacked. Storz and colleagues [1] demonstrated clearly the interest of such new 3D systems. Although preliminary, these results have opened a road toward new horizons.

With the development of augmented reality and surgical navigation, the 3D technology is an obvious and important step [4]. The integration of 3D laparoscopy with new devices and tools for real-time navigation can lead to a revolution (Fig. 3). Programing the intervention, simulating the procedure, and teaching the operation ex vivo are just some of the possibilities offered by these new surgical innovations. Even more interesting, findings have shown the navigation not only to be feasible and safe but also to be an obvious help during open surgery.

Concerning minimally invasive surgery, the experience is more limited, but the possibilities are endless. The use of a 3D laparoscope coupled with a 3D screen, as we have tested, is just a step toward advanced surgical navigation. Many have recognized the interest of these techniques for solid organ tumor surgery. Hepatic resections probably are a good model for intraoperative navigation [5]. However, to offer a minimally invasive approach to these patients, a 3D environment is necessary and can be given by the 3D

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Fig. 1 Three-dimensional exploratory laparoscopy for peritoneal carcinomatosis

Fig. 2 Three-dimensional laparoscopic cholecystectomy

screen and scope, as was the case with robotics. Finally, we are just at the dawn of an upheaval without precedent.

Of course, new challenges are arising [6]. These challenges include surface reconstruction, images overlying, plastic deformation, and real-time radiologic images, to name a few. The directions of advanced surgical navigation are correlated with the possible improvements we may demonstrate in the near future.

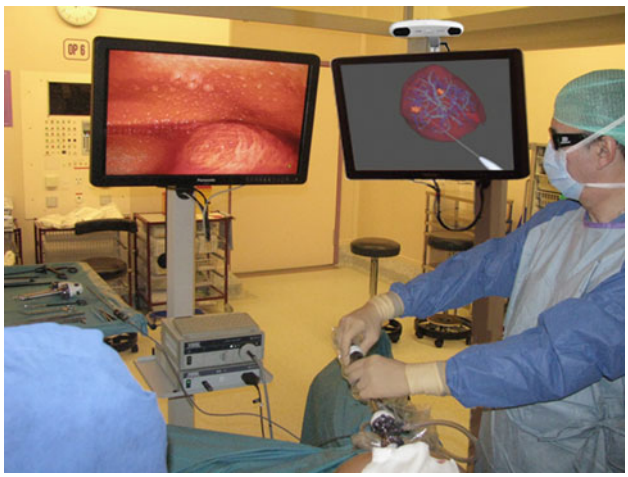

Fig. 3 Future developments by integration of a three-dimensional (3D) laparoscopic environment into an advanced 3D interface for surgical navigation

The challenge of 3D navigation is one of the most exciting topics in the field of new surgical technologies. The interest, even if modest today, is expected to grow.

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