Perspective Article

The Role of Three-dimensional Laparoscopy in Gynecology: Time to Revise Our Perspective?

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Minimally invasive surgery in the form of two-dimensional (2D) laparoscopy has been the gold standard for increasing number of gynecological procedures for almost three decades now. However, there are still centers in the world where conventional laparotomy is preferred by gynecologists. This is primarily due to the struggle one faces with loss of the "third dimension" or "perception of depth" in 2D laparoscopy. This makes the learning curve slower and steeper as compared to open surgery.

While over the years, with practice, minimally invasive gynecologists have got accustomed to the loss of binocular vision when operating, and have learned to use monocular depth cues such as light and shade, relative size of objects, object interposition, texture gradient, and motion parallaxe,[1] it remains a challenge for few.

Depth perception is the visual ability to judge the relative distance of objects and the spatial relationship of objects at different distances. As the three-dimensional (3D) world projects onto a 2D retina, this projection on its own cannot provide depth information. The brain has to combine various monocular and binocular cues given by the eyes to recover the depth, distance, and 3D shape of objects.

This lead to the development of the 3D scope and technology in the early 1990s. It was presumed to overcome the main limitation of a 2D surgical field, hoping to make the hand–eye coordination easier for new surgeons.

However very quickly feedback from surgeons circulated negativity amongst most centers. This included ocular fatigue, onset of headaches as well as the scopes being large and bulky leading to hand fatigue. Following the approval by the Food and Drug Administration of the Da Vinci Surgical System in 2005, there was an increasing trend toward the use of the robotic assistance. The high-definition 3D vision provided on the surgical console, along with the better ergonomics with endo–wrist movements, was considered a game changer in the field of minimally invasive surgery.[2-4] This rekindled the interest in 3D vision among many surgeons; reminding us it is a technology which has been in the market for many years; however had not percolated most institutes.

Earlier models for 3D laparoscopy were limited by suboptimal image quality and had heavy active shutter glasses, but technological advancements have enabled sophisticated high-resolution systems and light polarizing glasses that are lighter and more comfortable.

Today, what we use is a dual-channel optical scope which is connected to two video cameras and delivers two pictures that are displayed to the viewer on a stereoscopic display. When the surgeon wears circular, polarized 3D glasses, the two images are merged by the brain into one, and this gives the perception of depth.

Over the three decades, there have been controversial publications on the first-generation 3D high-definition laparoscopic surgeries. In 1998, Hanna *et al*.[5] showed that

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there were no advantages from the use of 3D laparoscopic system. However, with the new-generation 3D high-definition systems, both inexperienced and experienced surgeons reduce their time of operation and there is no headache, dizziness, or ocular fatigue observed; some studies have even shown a significant benefit.[6-9] 3D laparoscopy appears to improve speed and reduce the number of performance errors when compared to 2D laparoscopy.[10] However, most studies to date assessed 3D laparoscopy in simulated settings, and the impact of 3D laparoscopy on clinical outcomes has yet to be examined.

In today's era, a discussion on gynecological surgery would be incomplete without considering the skills and surgical understanding required to treat endometriosis, perhaps one of the most technically challenging surgeries in gynecology.[11-14] The dense adhesions, distorted anatomy, skewed surgical planes, and the poor reproductive outcome put enormous pressure on the surgeon to do a complete and thorough job. The goal is always normalizing pelvic anatomy, leaving behind zero residual lesions. After a 2D laparoscopic surgery for endometriosis, often, a gap is felt of what the surgeon wanted to achieve during the surgery and what he is able to achieve. However, it is possible to bridge this gap using 3D vision that enables the surgeon with a detailed and more precise view. Surgeon with a detailed and more precise view; so one can better visualize the pathology; in order to treat or resect / excise.

A study compared results of using the 3D/HD scope and the 2D/HD laparoscope for visual detection of histologically confirmed endometriosis. The primary aim included comparisons of 2D and 3D visualization for the detection of lesions with atypical appearance, small size, and those anatomically located in the pelvic cul-de-sac.[15] The results of this study indicated that the 3D/HD endoscope was associated with a 2.36 (95% confidence interval: 1.20–4.66, $P = 0.014$) greater probability of visualizing a positive lesion when compared to the 2D/HD laparoscope, irrespective of patient age, body mass index, prior surgery for endometriosis, lesion width, depth, appearance, and location as well as Revised American Society for Reproductive Medicine (rASRM) score clinical stage of disease.

While one may argue, with the robotic platform now available in many countries, would revisiting 3D laparoscopy be taking a step back in time?

The development of robotic surgery in the recent years has demonstrated the multiple advantages of a full immersion 3D high-definition vision; however, this comes with a plethora of constraints of its own. It begins with a high cost of installation and maintenance of the robotic surgical system. It is associated with a renewed learning curve even for experienced laparoscopic surgeons. Apart from lacking haptic feedback, it is challenging to apply torque which is essential in benign gynecological procedures such as removal of large myomas. The robotic surgical system may not be necessary for many routine procedures with benign conditions, for which 3D laparoscopy vision systems may be a more relevant option.

Thus, we believe that the use of the new-generation 3D high-definition laparoscopic system can be considered a favorable "hybrid" and may be a mid-ground, combining two different elements: improved quality of vision (3D from robotic surgery) and tactile feedback and proprioception (from laparoscopy). The initial investment and recurring costs are low compared to robot-assisted surgeries, thus providing a more balanced cost–benefit ratio.

To summarize, the debate really is "Is it the use of robotics that can improve the quality of surgery and improve the learning curve?" or "Is it the 3D view on the screen that will enhance the skills of surgeons and improve the quality of advanced surgery?"

We need more prospective studies and randomized controlled trials by experienced surgeons using the various systems to have a more conclusive answer.

3D high-definition systems can be considered a good practical interim solution between the 2D system and the robotic system, one that can be implemented at almost all centers having laparoscopy equipment. Only time will tell; but maybe 3D surgery will eventually replace the conventional 2D laparoscopy in the near future and its time to revise our perspective!

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