3 Dimensional Vision in Gynecological Procedures: A whole new world!

Yang F, Ng YW, Kiew J, Fong YF

ABSTRACT

Objective: *To describe the application of 3D vision technology in gynecological laparoscopic surgery in daily clinical practice. We described the peri-operative outcomes of laparoscopic procedures using 3D imaging, including surgeons' and nurses' perspectives on its use.*

Methodology: *3D laparoscopy® (Karl Storz) was employed in both emergency (ectopic pregnancies) and elective gynecological surgeries (hysterectomy and ovarian cystectomy). Feedback was obtained from surgeons and scrub nurses involved in the surgeries. Casenotes of the patients were analyzed to evaluate peri-operative outcomes.*

Results: *A total of five cases were analyzed: two emergency cases of salpingectomy for ectopic pregnancy and three elective cases of hysterectomy and ovarian cystectomy. The peri-operative outcomes were good in all cases with no complications. Surgeons reported improved resolution of images, ease of dissection and suturing but nurses found the quality of images similar to conventional laparoscopy. Challenging laparoscopic skills such as suturing was improved with better spatial and depth perception.*

Conclusion: *As we poised beyond the boundaries of laparoscopy, enhancement in imaging is an essential component of laparoscopic surgery. The improved spatial/depth perception and higher image resolution will ease the learning curve of laparoscopy, especially among the residents. Larger series are required to assess the safety profile of its application.*
Words count: 200

Keywords: 3-dimensional imaging, 3D laparoscopy, stereoscopic vision, spatial orientation, image resolution.

Feng Yang
Medical Officer
Department of Obstetrics and Gynecology,
National University Hospital, Singapore

Ng Ying Woo
Consultant
Department of Obstetrics and Gynecology,
National University Hospital, Singapore

Jolene Kiew
Consultant
Yong Loo Lin School of Medicine,
National University of Singapore

A/Prof Fong Yoke Fai
Senior Consultant
Department of Obstetrics and Gynecology,
National University Hospital, Singapore

Corresponding Author:
Dr Ng Ying Woo
Department of Obstetrics and Gynecology, National University Hospital, 5 Lower Kent Ridge Road, Service Block, Basement, Singapore 119074.
Email: ying_woo_ng@nuhs.edu.sg

INTRODUCTION

Imaging is an essential component in performing successful laparoscopic surgery. Often, it is said that "you can only operate when you can see". Having a good vision during laparoscopic surgery is not only essential; it is also necessary to ensure safety during the procedure. Hopefully, technological revolution can make one see better during surgery. One of the major disadvantages in laparoscopy is the loss of three dimensional (3D) vision when a three dimensional image is represented on a two dimensional screen. This results in poorer depth perception[1] and thus surgeons are required to learn to use other visual cues to compensate for the lack of binocular vision. This increases the learning curve in laparoscopy.[2, 3, 4]

In the last couple of years, high definition vision has been rapidly embraced by many surgeons, and it has demonstrated superior objective performance characteristics compared with standard laparoscopes.[5] Many touted that the excellent resolution enhanced recognition of planes and eased dissection during laparoscopy. Nowadays, it is becoming an indispensable necessity in the operating theatre. 3D technology was introduced in the early 1990s as the potential benefits were recognized[6]; however, it did not take off as the technology was cumbersome and not user-friendly. There have been many ex-vivo studies comparing the use of 3D monitors and 2D monitors in laparoscopy. While many studies have demonstrated significant advantages in the use of 3D monitors in terms of task performance and teaching of laparoscopic skills to inexperienced learners[3, 7, 8,] there have also been studies demonstrating that there is no significant benefit[9, 10, 11] of 3D laparoscopy. Surgeons have also reported increased visual strain, headache and facial discomfort with the use of 3D system in the early days of 3D laparoscopy[10].

Nevertheless, we are seeing a revolution as the technology of 3D imaging has moved on to the next platform. It is imperative to introduce it into our surgical field and hopefully, this will one day prove to be superior in terms of peri-operative outcomes and safety profile. With the improvement in technology, it has been suggested that the disadvantages of 3D laparoscopy has been reduced.[12]

Literature on the application of 3D laparoscopy in clinical use in gynecology was sparse. In this paper, we described five patients who have undergone 3D laparoscopy in gynecological procedures in Singapore, as well as obtained feedback from surgeons and nurses involved in these 3D laparoscopic surgeries.

METHODOLOGY

A retrospective study was conducted in the Department of Obstetrics and Gynecology, National University Hospital in Singapore. We analyzed five patients who underwent 3D laparoscopic procedures for emergency and elective gynecological conditions. A questionnaire survey was administered to the surgeons and nurses to obtain feedback on their experience of performing 3D laparoscopic surgeries.

3D IMAGING EQUIPMENT

The Karl Storz 3D laparoscopic equipment was used in this study. The set up of 3D laparoscopy was similar to that of conventional 2D imaging. The equipment included a 3D-LCD TV, 3D converter unit, 10mm rigid 35cm 3D telescope and the accompanying 3D glasses for all the theatre staff, as shown in Figure 1.

The quality of the images was excellent with the 3D vision (Figure 2). Details of the surgical field were vivid and clear. The telescope uses similar light cable as the conventional telescope and it is lightweight (Weight of camera = 217gm) and easy to handle. The buttons on the telescope allows the surgeon to take snapshots of operative images, with a choice of 2D or 3D images. The white balance and focusing functions are similar to that of the conventional telescope.

All the surgeons operated in the usual fashion (Figure 3). It was not necessary to remove the 3D glasses even when direct vision was required during the surgery, which is an advantage compared to the active-liquid-crystal shutter-glasses used to visualize 3D images in the past. [13]

CASE SUMMARIES

The casenotes of the five patients in our study were collected and peri-operative outcomes were analyzed. There were two emergency cases of ectopic pregnancy with salpingectomy and three elective cases of hysterectomy and ovarian cystectomy. Of the emergency cases, one patient presented with an acute abdomen secondary to a ruptured ectopic pregnancy while undergoing medical treatment using methotrexate. Both patients had emergency laparoscopic salpingectomy employing 3D imaging technology. Of the elective cases, one patient underwent a total laparoscopic hysterectomy for removal of uterine leiomyoma and two others had a laparoscopic ovarian cystectomy. The patients' demographics and outcomes are summarized as below. (Table 1)

SURVEY

A retrospective self-administered questionnaire survey was carried out on eight surgeons and seven scrub nurses, who performed 3D laparoscopic surgeries, to obtain feedback on the set-up, ease of use, quality of vision and adverse effects of using 3D imaging in laparoscopy. Surgeons and nurses scored the ease of set-up of equipment, ease of dissection and suturing and depth perception, sharpness and contrast of the images out of ten when comparing the use of 3D laparoscopy to 2D laparoscopy based on their experience. Surgeons and scrub nurses were also surveyed on the presence

of adverse effects such as headaches, facial discomfort and visual strain, and whether they would like to use 3D laparoscopy again.

RESULTS

In general, surgeons scored the set-up, ease of use and quality of vision higher than nurses. Surgeons found it easier to set up the 3D equipment and easier to dissect and suture using 3D laparoscopic equipment compared to conventional 2D laparoscopy. The ease of suturing was scored the highest. Surgeons also found the quality of vision in 3D laparoscopy better than 2D laparoscopy in terms of depth perception, sharpness and contrast of the images. The mean scores of the survey results are summarized in Table 2.

Despite the advancement in 3D laparoscopic equipment, a small proportion of surgeons and nurses experienced adverse effects such as headache, facial discomfort, visual strain and dizziness. Table 3 summarizes the number of surgeons and nurses who have experienced adverse effects. 6 out 8 surgeons and 3 out of 7 nurses would like to use 3D laparoscopy again, especially to perform more complex surgeries where improved depth perception could be more beneficial.

DISCUSSION

Imaging is an essential component of laparoscopic surgery. We have always been taught that "one can only operate if one can see". This principle is even more so important in laparoscopy where one needs to "see more clearly". The loss of spatial and depth orientation6 in 2D laparoscopy is a frustrating disadvantage in laparoscopy for both residents and surgeons, especially when the case is complicated. Availability of the 3D vision practically removes this handicap and give the "correct" vision back to the surgeon, aiding the accomplishment of more complex laparoscopic tasks.[1,3]

Although 3D imaging was first introduced in the 1990s, it did not take off due to the limitations of the technology. The camera or telescope was bulky and cumbersome to handle.[13] Heavy and ill-designed 3D glasses often resulted in visual strain, headache and fatigue for the operating staff.[10] Nevertheless, it was still an attractive vision for many who believed in laparoscopic surgery. The research and development of this technology in the last decade proved that 3D technology will surely stage a comeback and re-ignite the interest in the arena of laparoscopy.

Our centre was fortunate to secure the 3D laparoscopy equipment from Karl Storz for a short period. We attempted this technology in a variety of gynaeocological procedures, namely salpingectomy for ectopic pregnancy, ovarian cystectomy and hysterectomy. The technology proved to be robust even in emergency settings as set-up was similar to conventional laparoscopy. In addition, the lightweight camera head was greatly appreciated by the assistant. The high-definition images facilitated the surgery and allowed better visualization of the tissue planes. Nevertheless, we observed that the clarity of vision was affected when either of the two lenses at the tip of the telescope came into contact with fluid. Additional time and effort were required to clear the vision and to allow the surgery to proceed. This disadvantage was especially crucial in ectopic pregnancy where the vision has already been obscured by the haemoperitoneum.

We chose to use 3D vision in hysterectomy since dissection and suturing were required in this procedure. The effects of regaining both the spatial and depth orientation were greatly appreciated during dissection of the bladder and suturing of the vault, as sutures could be exactly and rapidly applied when using 3D imaging.[13] From the results of our survey, the ease of dissection and suturing were rated the highest, showing that 3D vision conferred an advantage in this area. During the surgery, we had noticed that the images were clearer and brighter when the surrounding operating room lights were dimmed. As the 3D glasses do not fully enclose the surgeons' eyes, the additional surrounding lights may interfere with the clarity of the 3D images.

3D laparoscopy also proved to be advantageous during cystectomies as the improved quality of vision using 3D imaging allowed for better recognition of planes in the dissection of ovarian cysts. We postulate that the improved imaging may allow better ovarian preservation, although larger studies are required to affirm this hypothesis. In addition, haemastasis could be accurately and precisely performed in order to minimize blood loss as the bleeding points were clearly and accurately visualized with this enhanced vision.

CONCLUSION

In summary, the results of this study supported that the peri-operative outcomes of patients who have undergone 3D laparoscopy were good with no complications, and surgeons responded with improved resolution of images, ease of dissection and suturing. We

recognized that there remained disadvantages such as adverse effects experienced by surgeons and the need for operating room lights to be dimmed for clearer and brighter images. However, despite the disadvantages, majority of surgeons surveyed would like to use 3D laparoscopic equipment again. We believed that 3D imaging technology had great potential in improving the operative outcomes of more complex laparoscopic surgeries given the better image quality, and larger studies evaluating the safety profile of 3D laparoscopy should be performed.

REFERENCES

1. *Heemskerk J, Zandbergen R, Maessen JG, Greve JW, Bouvy ND. Advantages of advanced laparoscopic systems. Surg Endosc. 2006 May;20(5):730-3.*

2. *Medeiros LR, Stein AT, Fachel J, Garry R, Furness S. Laparoscopy versus laparotomy for benign ovarian tumor: a systematic review and meta-analysis. Int J Gynecol Cancer. 2008 May-Jun;18(3):387-99.*

3. *O. J. Wagner, M. Hagen, A. Kurmann, S. Horgan, D. Candinas, S. A. Vorburger. Three-dimensional vision enhances task performance independently of the surgical method. Surg Endosc. 2012 Oct;26(10):2961-8.*

4. *Smith R, Day A, Rockall T, Ballard K, Bailey M, Jourdan I. Advanced stereoscopic projectiontechnology significantly improves novice performance of minimally invasivesurgical skills. Surg Endosc. 2012 Jun;26(6):1522-7.*

5. *Pierre SA, Ferrandino MN, Simmons WN, Fernandez C, Zhong P, Albala DM, Preminger GM. High definition laparoscopy: objective assessment of performance characteristics and comparison with standard laparoscopy. J Endourol. 2009 Mar;23(3):523-8.*

6. *Cuschieri A. Visual display technology for endoscopic surgery. J Min Inv Ther. 2009 July;5(5): 427–434*

7. *Votanopoulos K, Brunicardi FC, Thornby J, Bellows CF. Impact of three-dimensional vision in laparoscopic training. World J Surg. 2008 Jan;32(1):110-8.*

8. *Patel HR, Ribal MJ, Arya M, Nauth-Misir R, Joseph JV. Is it worth revisiting laparoscopic three-dimensional visualization? A validated assessment. Urology. 2007 Jul; 70(1):47–9*

9. *Chan AC, Chung SC, Yim AP, Lau JY, Ng EK, Li AK. Comparison of two-dimensional vs three-dimensional camera systems in laparoscopic surgery. Surg Endosc. 1997 May; 11(5):438–40*

10. *Hanna GB, Shimi SM, Cuschieri A. Randomised study of influence of two-dimensional versus three-dimensional imaging on performance of laparoscopic cholecystectomy. Lancet. 1998 Jan 24;351(9098):248-51.*

11. *Mueller MD, Camartin C, Dreher E, Hanggi W. Three dimensional laparoscopy: gadget or progress? A randomized trial on the efficacy of three-dimensional laparoscopy. Surg Endosc. 1999 May;13(5):469-72.*

12. *Yamauchi Y, Shinohara K. Effect of binocular stereopsis on surgical manipulation performance and fatigue when using a stereoscopic endoscope. Stud Health Technol Inform. 2005; 111: 611–4*

13. *Wenzl R, Lehner R, Vry U, Pateisky N, Sevelda P, Husslein PSO. Three-dimensional video-endoscopy: clinical use in gynaecological laparoscopy. Lancet. 1994 Dec 10;344(8937):1621-2.*

Figure 1: Karl Storz 3D Laparoscopic equipment
A: 3D LCD-TV and converter; B: Telescope;
C: 2x CCD chips at the tip of the scope; D: 3D glasses

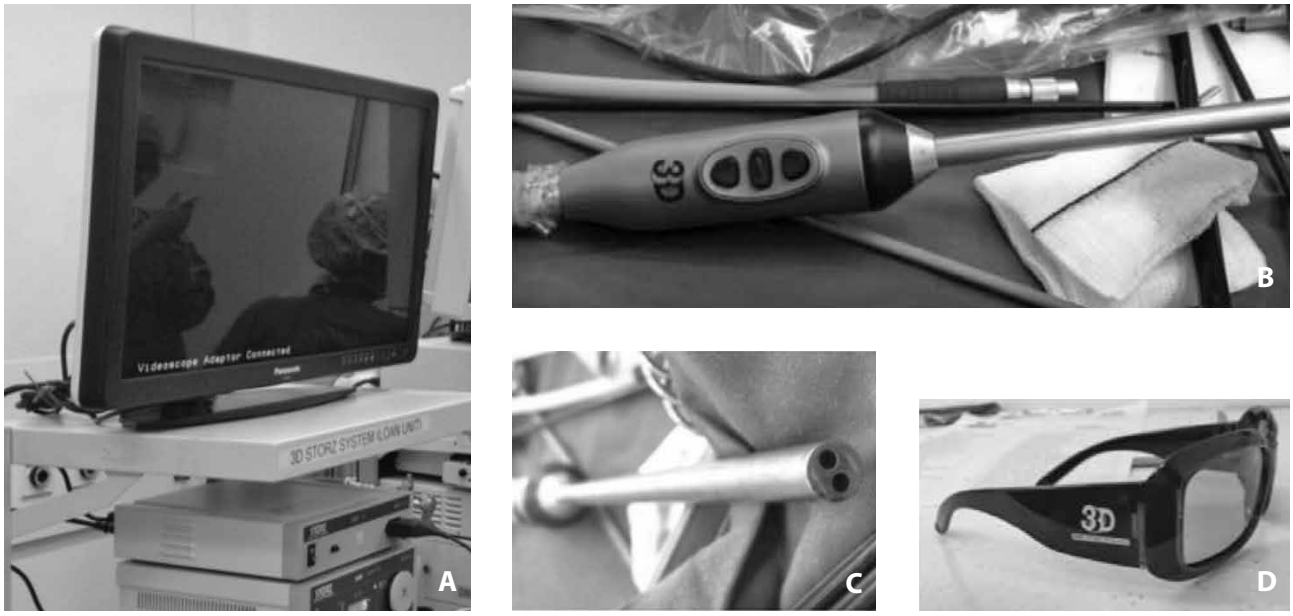

Figure 2: 3D images
A: 3D image from the LCD TV; B: Image via the 3D glasses

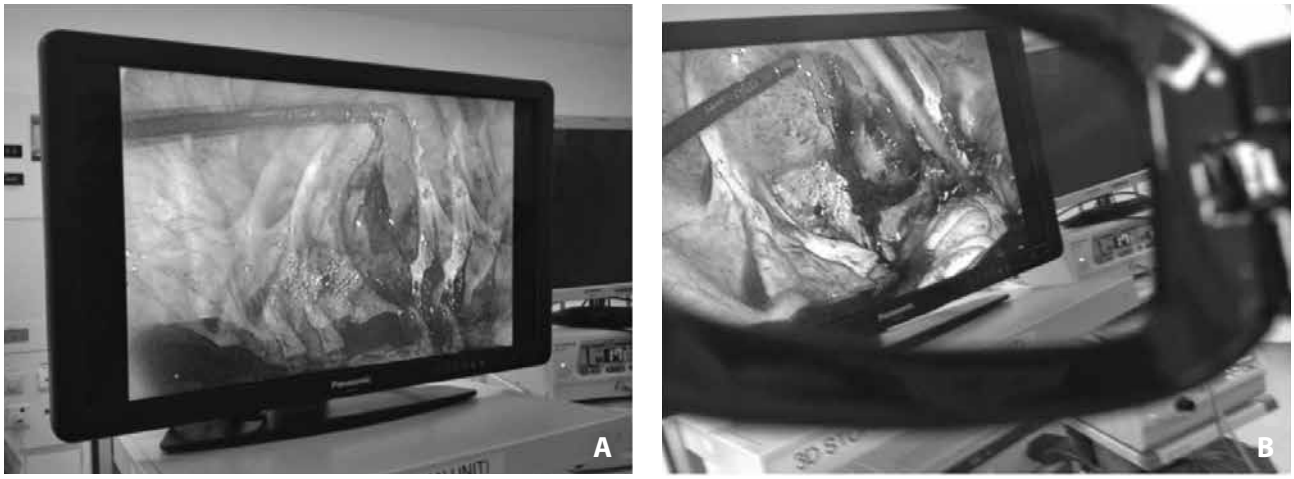

Figure 3: Operation
A: Similar operating fashion; B: No necessity to remove 3D glassess even when direct vision was required

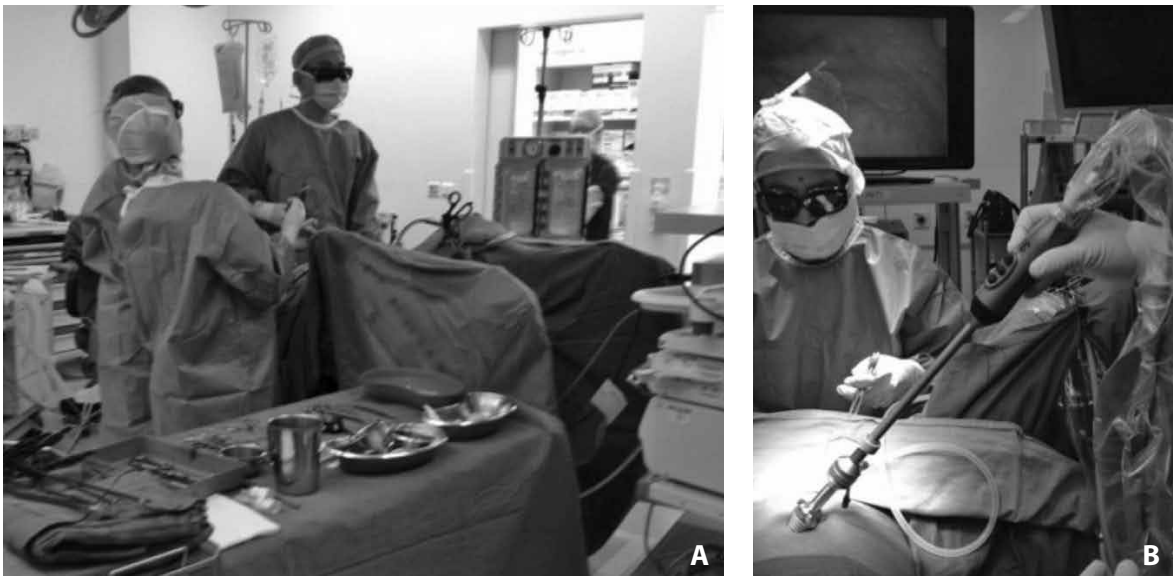

Table 1: Summary of patients' demographics and outcomes

Patient	P1	P2	P3	P4	P5
Age	32	28	44	29	23
Co-morbidities	No	No	No	No	No
Type of surgery	Emergency	Emergency	Elective	Elective	Elective
ASA Score	3E	1E	1	2	2
Diagnosis	Ruptured right tubal ectopic pregnancy	Unruptured right tubal ectopic pregnancy	Uterine leiomyoma	Right ovarian cyst (mature cystic teratoma)	Right ovarian cyst (mature cystic teratoma)
Surgery	Right salpingectomy	Right salpingectomy	Total laparoscopic hysterectomy	Right ovarian cystectomy and adhesiolysis	Right ovarian cystectomy
Operative findings	5cm ruptured right ectopic pregnancy and haemo-peritoneum	2cm unruptured right tubal ectopic pregnancy	18 weeks size, irregularly shaped uterus	Multiple cysts 2-6cm in right ovary and adhesions	6 cm right ovarian dermoid cyst containing mixed elements
Operating duration (min)	58	41	195	142	88
Estimated blood loss (ml)	1000	0	150	100	0
Post-operative hospitalization (days)	2	1	1	1	2
Complications	None	None	None	None	None

Table 2: Mean score (scale of 1-10) on set-up, ease of use and quality of vision of 3D laparoscopy as compared to conventional 2D laparoscopy

	Surgeon (n=8)	Nurse (n=7)
Set-Up	6.0 (4 – 8)	4.7 (3 – 5)
Ease of use		
• Dissection	7.7 (4 – 10)	*Not applicable
• Suturing	8.5 (6 – 10)	*Not applicable
Quality of vision		
• Depth perception	7.4 (5 – 10)	5.0 (4 – 7)
• Sharpness	7.6 (5 – 10)	5.3 (4 – 7)
• Contrast	7.4 (5 – 10)	5.9 (4 – 7)
• Overall	7.5 (5 – 10)	4.9 (2 – 7)

*Not applicable as nurses did not perform dissection or suturing

Table 3: Adverse effects experienced by operating staff during 3D laparoscopic surgery

	Surgeon (n=8)		Nurse (n=7)	
	Present	**%**	**Present**	**%**
Headache	3	37.5	3	42.9
Facial discomfort	1	12.5	1	14.3
Visual strain	2	25	3	42.9
Dizziness	1	12.5	1	28.6