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ORIGINAL ARTICLE

# Three-dimensional laparoscopy in urology: Initial experience after 100 cases

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**KEYWORDS**
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**Summary** *Objective:* To evaluate the efficacy of three-dimensional (3D) laparoscopy in urological procedures in a cohort study compared to two-dimensional (2D) laparoscopy.
*Methods:* From October 2016 to August 2017, 100 patients underwent various urological procedures with 3D laparoscopy performed by a single experienced surgeon at the University Medical Centre of Ho Chi Minh City. The surgeon's subjective assessment of image quality, depth perception, ease of intra-corporeal suturing and knotting was recorded. The State-Trait Anxiety Inventory for Adults (STAI-6) short version was used to quantify aspects of stress experienced during each operative procedure. A subgroup of 73 complicated 3D laparoscopic procedures (nephron sparing nephrectomy, nephrectomy, adrenalectomy, pyeloplasty and ureterolithotomy) was compared to the same clinical parameter group of 74 two-dimensional laparoscopic procedures, performed by the same surgeon in the year before to define the differences in operative time, blood loss and time taken for critical surgical steps during the procedures.
*Results:* Mean time of operation was 112.8 min $\pm$ 14.5 (range 45—210 min). Mean estimated blood loss was 54.7 mL $\pm$ 8.2 (range 20—100 mL). The surgeon's subjective assessment of image quality, depth perception, operative strain, ease of intra-corporeal suturing, and knotting, and hand—eye coordination was considered as good in 100% of cases. Mean score of STAI-6 was 11.6 $\pm$ 2.17 (range 10—22). Subgroup data analysis was all statistically better for 3D compared to 2D.
*Conclusion:* The use of 3D systems in laparoscopic urologic procedures resulted in better image quality and better surgeon performance with lower stress.


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## 1. Introduction

Laparoscopy has been increasingly adopted in urology over the last decades, and it is nowadays commonly used in the management of several uologic diseases. Traditionally, laparoscopy has been based on 2-dimensional (2D) imaging, which has represented a considerable challenge for those approaching this technique.[1] Thus, 3-dimensional (3D) visualization technology for laparoscopy has been proposed, since the early 1990s, as a way to facilitate laparoscopic performance. More recently, industry has developed novel 3D systems where the imaging is similar to stereoscopic vision, in which the depth perception is achieved by different unique image received by each eye. Thus, more recent studies have suggested a possible advantage provided by these new 3D systems during laparoscopic performance.[2–4]

The aim of this study was to evaluate the effect of 3D imaging on laparoscopic performance in urological procedures compared to 2D laparoscopy.

## 2. Materials and methods

In the Department of Urology at the University Medical Centre of Ho Chi Minh City, between October 2016 and August 2017, a cohort study was carried out on 100 patients who underwent various laparoscopic urological procedures performed by a single experienced surgeon using 3D system (IMAGE 1S-3D® – Storz). All patients provide informed, written consent and the study was approved by the Ethics Committee.

The Karl Storz 1S-3D® system consists of a binocular laparoscopic with two image sensors installed distallly. Zero degree and 30° fields of view models are available. The images from the distal sensors are transmitted to the 3D camera control system. Passive light glasses and a specific 3D monitor are required to use the endoscope in its 3D capacity.

Parameters such as total operative time, blood loss during surgery, hospital stay were assessed. The surgeon's subjective assessment of image quality, depth perception, operative strain, ease of intra-corporeal suturing, and knotting, and hand–eye coordination was recorded using a Likert scale. The State-Trait Anxiety Inventory for Adults (STAI-6) Short Version of Spielberger[5] was used to quantify emotional, physical, and cognitive aspects of stress experienced during each operative procedure. STAI is an introspective psychological inventory comprising a total of forty self-reporting items pertaining to anxiety affect and helps to measure anxiety at both poles of normal affect curve. Short six-item STAI-6 scale was chosen as it is well validated

**Table 1** Procedures performed with 3D systems.

| Procedures | Transperitoneal access | Retroperitoneal access | Sum |
|---|---|---|---|
| Ureteral reimplantation | 3 | 0 | 3 |
| Ureterocalycostomy | 1 | 0 | 1 |
| Nephron sparing nephrectomy | 3 | 14 | 17 |
| Nephrectomy (Radical/simple) | 3 | 7 | 10 |
| Radical nephro-ureterectomy | 2 | 0 | 2 |
| Orchiectomy | 1 | 0 | 1 |
| Adrenalectomy | 3 | 3 | 6 |
| Urachal cyst resection | 2 | 0 | 2 |
| Vesical diverticulectomy | 1 | 0 | 1 |
| Pyeloplasty | 8 | 5 | 13 |
| Inguinal hernia repair with mesh | 12 | 0 | 12 |
| Pyelolithotomy | 0 | 5 | 5 |
| Ureterolithotomy | 5 | 22 | 27 |
| Sum | 43 | 57 | 100 |

**Table 2** Comparison between two and three-dimensional laparoscopic procedures.

| Parameters | Value (mean ± standard deviation) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Adenalectomy (n = 13) | | | Nephron-sparing nephrectomy (n = 31) | | | Radicall/ simpe nephrectomy (n = 21) |
| | 2D (n = 7) | 3D (n = 6) | P | 2D (n = 14) | 3D (n = 17) | P | 2D (n = 11) |
| Operative time (min) | 100.2 ± 21.5 | 88.7 ± 18.6 | <0.013 | 140.5 ± 73.1 | 100.8 ± 45.6 | <0.012 | 176.8 ± 50.1 |
| Blood loss (mL) | 72.1 ± 17.5 | 43.7 ± 12.3 | <0.0001 | 140.1 ± 23.2 | 75.5 ± 55.7 | <0.026 | 240.2 ± 211.6 |
| Time taken for critical steps (min) | 31.7 ± 13.2 | 25.1 ± 10.3 | <0.012 | 59.2 ± 10.7 | 41.8 ± 10.3 | <0.0001 | 86.7 ± 21.6 |

2D = two-dimensional, 3D = three-dimensional, N/A = not available.

and more suitable when time constraints prevent administration of longer version (forty-item). Total STAI score ranges between six (minimum) and 24 (maximum), with the higher scores indicating increased psychological stress experienced during the procedure. This method was used to measure the overall stress experienced by the operating surgeon during the procedure.

A subgroup of 73 complicated 3D laparoscopic procedures (nephron sparing nephrectomy, nephrectomy, adrenalectomy, pyeloplasty, ureterolithotomy) was compared to the same clinical parameter group of 74 two-dimensional laparoscopic procedures, performed by the same surgeon in the year before. We reviewed recorded surgical videos of these cases to analyze and compare of time taken for critical surgical steps during the procedure that were defined as follows: (a) for laparoscopic ablative procedures — time taken for dissection of vascular pedicle, clipping of vessels, and cutting of vascular pedicle; (b) for laparoscopic reconstructive procedures — time taken for dissection of ureteropelvic junction, the creation of anastomotic flaps, suturing, and stenting; (c) for laparoscopic nephron sparing nephrectomy — time taken for dissection of vascular pedicle, cutting of tumor and suturing of kidney parenchyma; (d) for laparoscopic ureterolithotomy — time taken for dissection of the ureter at the stone location, opening of the ureter, retrieving stone and suturing of the ureterotomy site.

Statistical analysis was performed using the Student's t-test with SPSS software 14.0.

## 3. Results

Overall, 41 female and 59 male patients participated in the study. Mean age 39.4 ± 11.2 years old (range 17—76). Laparoscopic surgery was performed transperitoneally in 43 cases and retro-peritoneally in 57 cases. Table 1 presents types of operation in the study. There was no conversion to open surgery. Mean time of operation was 112.8 min ± 14.5 (range 45—210 min). Mean estimated blood loss during operation was 54.7 mL ± 8.2 (range 20—100 mL). Mean post-op hospitalization was 4,6 days ± 1,7 (range 2—7 days).

The surgeon's subjective assessment of image quality, depth perception, operative strain, ease of intra-corporeal suturing, and knotting, and hand—eye coordination was considered as good in 100% of cases. Mean score of STAI-6 was 11.6 ± 2.17 (range 10—22). We did not notice any side effects associated with 3D laparoscopic imaging as headache, nausea and eye strain.

Data of subgroup comparison is given in Table 2. Operative time, blood loss and time taken for critical surgical steps during the procedures were all statistically better for 3D.

## 4. Discussion

3D imaging is not new to laparoscopy. However, early experience in the 90s was limited by the poor image quality, which did not foster a clinical implementation of the technology.[6] More recently, the industry was able to develop more advanced 3D imaging systems, which can provide a stereoscopic vision, so that the depth perception is more effectively obtained. The availability of such systems has generated renewed enthusiasm toward the use of 3D vision for laparoscopy.

In 2015, Bjerrum et al conducted a systemic review which included 31 randomized controlled trials (3 carried out in a clinical setting and 28 used a simulated setting).[7] The included RCTs were categorized into four groups according to the effect of 3D vision on performance time, precision, side effects and cognitive workload. Twenty-two trials (71%) reported significantly reduced performance time using 3D vision systems compared with 2D. Twelve trials (63%) reported a lower rate of errors when the task was performed with 3D vision compared with 2D. Eight trials investigated the subjective evaluation of cognitive workload. Of those eight trials, five trials favored 3D visualization. Half of the trials reported side effects (discomfort, dizziness, eye strain, nausea and tiredness). The newest RCTs showed a benefit in almost 80% of the studies (2004—2014), whereas only 40% of the older studies (1994—2004) reported this benefit, possibly attributed to the development of improved 3D visualization equipment. Findings from our study also suggested that 3D visulization system satisfied surgeon in surgical performance.

Studies have shown clear advantages of the 3D system in those who are in training, rather than in surgeons who have already obtained proficiency in advanced laparoscopic procedures, the reasons being improved co-ordination, spatial awareness, and timing in comparison to the traditional 2D imaging.[2,8] 3D laparoscopy can reduce the time needed to learn laparoscopy and hence will be beneficial for the training of junior residents. Romero-Loera reported a comparative study including only newcomers who have no experience in laparoscopy and concluded that 3D is superior than 2D with the higher percentages of tasks completion, less time in performing them, and a shorter learning curve

| Value (mean ± standard deviation) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Pyeloplasty (n = 25) | | | Ureterolithotomy (n = 30) | | |
| 3D (n = 10) | P | 2D (n = 12) | 3D (n = 13) | P | 2D (n = 30) | 3D (n = 27) | P |
| 143.5 ± 37.3 | <0.041 | 160.7 ± 47.5 | 120.2 ± 39.4 | <0.012 | 75.3 ± 8.5 | 52.6 ± 4.7 | <0.013 |
| 160.7 ± 165.3 | <0.038 | 65.3 ± 21.3 | 37.1 ± 10.4 | <0.018 | N/A | N/A | N/A |
| 51.7 ± 24.5 | <0.021 | 80.8 ± 20.2 | 45.5 ± 9.1 | <0.0001 | 49.3 ± 7.2 | 35.7 ± 5.6 | <0.001 |

involved in 3D.[9] This is very important when we consider how we should go about setting up training for newcomers to the field of laparoscopic surgery.

All procedures in our study were performed by a senior surgeon who had extensive experience in laparoscopic surgery. Experienced laparoscopic surgeons may not always need the 3D system as they can use shadow or movement parallax as depth cue instead of stereovision. However, studies carried out by Ohuchida and Cicione have, respectively, suggested that 3D system may contribute in reducing surgical accidents and could facilitate hand versatility in surgeon with preexisting laparoscopic skills.[8,10] The latter prospective observational study involving standardized tasks in dry laboratory setting concluded that 3D imaging facilitated performance of Urological surgeons, mainly the beginners.[8]

In our study, blood loss when compared to 2D was less in 3D due to better dissection and identification of vascular structures. Even control of bleeders was better for 3D due to better depth perception leading to prompt identification of bleeders. Our study also showed a reduced time taken for 3D laparoscopy when compared to conventional 2D laparoscopy due to clear vision, good depth perception, proper hand—eye coordination, good tissue edge holding, more precise needle direction and suture picking when performing with 3D imaging.

Three-dimensional technology is still more expensive than standard 2D equipment.[11] However, the advantages they provide when compared to 2D makes them attractive. The 3D systems try to bridge the huge gap between 2D and robotics by providing certain advantages of robotic surgery at lower cost. The present 3D laparoscopic systems can be compared to robotic surgical systems in terms of good depth perception, reduced stress to surgeons along with advantages of being more cost-effective and ease of mobility.[12] Bhayani and Andriole have expressed that it is unclear whether the robotic system offers any advantages over a smaller and less expensive 3D system.[13] Although wristed instruments might seem to be a technological advance with an existing 3D view, it might be possible for surgeons to become proficient over an equally short learning curve. The cost savings for such proficiency, however, are overwhelmingly in favor of a 3D non-robotic tower, which costs less than one-tenth the price of a surgical robot. In addition, the nonrobotic tower is more mobile and might be used for any laparoscopic procedure. Park reported a comparative study between 2D, 3D, and robotic systems involving beginners and senior surgeons in the field of laparoscopy and concluded that robot was helpful in beginners, whereas experienced surgeons performed the task equally good in all the systems, even faster in 3D laparoscopy when compared to robot.[14]

The likely shortcomings of our study may be counted as lack of multicenter randomized controlled trial comparing with 2D systems and lack of bigger sample size.

## 5. Conclusion

The latest generation of 3D laparoscopic imaging system provided depth perception and spatial orientation, which was absent in conventional 2D system. The use of 3D systems in laparoscopic urologic procedures resulted in better image quality and better surgeon performance with lower stress. These systems may offer to fill the gap between two-dimensional laparoscopy and robot assistance and could be used as a replacement for robotic system in many routine procedures, especially in developing country like Vietnam.

## Conflicts of interest

None.

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