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Original Article

Role of 3-D1mentional Technology in Laparoscopic Surgery

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Abstract

Introduction: This study is done to evaluate role of 3-dimentional technology in laparoscopic surgery.

Materials and Methods: This is an observational study. Thirty patients selected from patients admitted electively to Sassoon general hospital which are fit for surgery and suitable for laparoscopic procedure after due written informed consent. For example, cholelithiasis, appendicitis, hiatus hernia, rectal prolapse, inguinal hernia, choledocholithiasis, obesity hypersplenism, and idiopathic thrombocytopenic purpura. Thirty patients were operated in a period of 24 months using Olympus 3D laparoscopy system by senior most laparoscopic surgeon with his trained team in our institute. Selected patients were operated and each case was evaluated in terms of age, sex, time required for the procedure, blood loss, and any other complications. After each case, operating surgeon was interrogated with respect to improvement in skill such as endoscopic suturing and experience about depth perception was recorded using Likert scale.

Results: In the present study, we operated total 30 cases using 3D technology. Most of the patients are between 21 and 30 years (about 33%) followed by 31–40 (about 30%) years age group. In the present study, about 60% patients (n718) are male while 40% are female (*n* = 12 we found that time required for the procedure has significantly decreased using 3D system. More than 213rd cases required less time for operation. Average time required for cholecystectomy in the present study was 27.86 min (standard time is 30 min). While average time required for appendectomy was 23 min (standard time being 25 min.). Average time required for lap fundoplication in the present study is 65 min (standard time is 90 min). Average time required for lap splenectomy in the present study is 110 min (standard time being 120 min). In the present study, average time required for lap rectopexy is 60 min (while standard time being 90 min). Average time required for lap choledochoduodenostomy, in the present study, is 120 min (standard time being 150 min). Whereas in the present study, average time required for lap sleeve gastrostomy is 80 min (standard time being 120 min. In present study, only intraoperative complication was seen in only one case, that is, of salpingectomy where injury to blood vessel has occurred that resulted in blood loss of about 500 cc. Eventually bleeding has been controlled using bipolar and rest of the procedure was uneventful, that is, intraoperative complications are significantly reduced. In the present study, surgeon has noticed significant improvement in skills such as end suturing and knotting in all cases. In the present study, we interrogated the surgeons about depth perception using 3D system after each case.

Conclusion: On the basis of results, conclusions are made as – Surgeon found improved depth perception. Thus 3–0 improves depth perception and thereby improves surgical performance of the surgeon. Time required for the procedure was significantly decreased as compared to standard more so ever in advanced laparoscopy cases. Thus, 3–0 significantly decreases time required for the procedure. Blood loss was found in significantly less number cases. Thus, 3–0 technology helps in minimizing blood loss. Intraoperative complications were found in only one case in the present study. Thus, 3–0 technology helps in minimizing intraoperative complications. Surgeon found improvement in skills such as endosuturing and intracorporeal knotting. Thus, 3D improves skills of surgeon. All these features of 3–0 collectively help to improve perioperative outcome and decreased hospital stay of patient.

Key words: 3D technology, Laparoscopy, Stereoscopy

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INTRODUCTION

Laparoscopic surgery is currently regarded as standard treatment in numerous surgical endeavors. Advances in endoscopic surgery have provided patients with less post-operative pain, shorter hospital stays, early discharge from hospital and an earlier return to work. For the

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surgeon, however, endoscopic surgery seems to be more stressful than open surgery. For example, several skills that are not required for open surgery are necessary for endoscopic surgery. The lack of stereoscopic vision on a two dimensional (2D) display is one of the significant difficulties for the endoscopic surgeon, who performs laparoscopic surgery. The lack of stereoscopic vision on a 2D display causes visual misperceptions based on the loss of depth perception. To compensate for this lack, expert endoscopic surgeons use visual clues from a 2D display, such as relative motion of the endoscope, familiar anatomy, object interposition, and the size of anatomical structures.[1,2] The lack of depth perception and spatial orientation when using 2D imaging is a recognized limitation of laparoscopic surgery in comparison with open surgery; this directly affects surgical performance, time required for the operation, morbidity, and patients' post-operative quality-of-life.[3]

Introduction of 3D imaging has removed many of these technical obstacles. In 1993, Becker *et al*. reported that a 3D display might improve laparoscopic skills.[4] Since then many researchers have demonstrated benefit of 3D imaging.[5] Despite the significant advantages claimed, 3D systems have not been widely accepted. Poor image quality due to technological limitations of early 3D equipment's and the high price of these systems could be the possible reasons. Furthermore, most of the studies which showed superiority of 3D system have been conducted using end trainer and experimental surgical model.[6,7] 3D vision offers the advantage of improved depth perception and accuracy comparable to open surgeries. Visual performance and motor skills are a function of depth perception allowing improved discrimination and recognition of targeted organs and their parts.

Hence, our present study intends to analyses the effect of 3D technology on operative performance during various elective laparoscopic surgeries and to assess its advantages and disadvantages.

Aims and Objectives

1. To study the effect of 3D laproscopy on depth percepion
2. To study the effect of 3D laproscopy on time required to for the procedure
3. To study the effect of 3D laproscopy on the intraopeartive complications
4. To study the effect of 3D laproscopy on endoscopic suturing.

MATERIALS AND METHODS

This is an observational study

1. 3D laparoscopy system consists of:-
   a. 3D visualization unit olympus 3DV-190
   b. Evis exera II video system center olympus CV-190
   c. Medical 3D LCD monitor LMD-2451 MT
   d. Polarized 3D glasses bm-30 g/bim-31 g
   e. The high-intensity light source (olympus CLV-s190)
   f. 3D laparoscope- endoeye flex 3D deflectable videoscope olympus LTF-190–10–3D
2. CO_2 insufflator
3. Laparoscopic instruments
4. Harmonic system and probe
5. Various suture materials and dressing material.

Thirty patients selected from patients admitted electively to Sassoon general hospital which are fit for surgery and suitable for laparoscopic procedure after due written informed consent. For example, cholelithiasis, appendicitis, hiatus hernia, rectal prolapse, inguinal hernia, choledocholithiasis, obesity, hypersplenism, and idiopathic thrombocytopenic purpura. All the patients selected are evaluated for blood parameters, chest X-ray, electrocardiography (ECG), and disease-related investigations. Patients with deranged blood parameters ECG or chest X-ray findings were excluded from the study. 30 patients were operated in a period of 24 months using Olympus 3D laparoscopy system by senior most laparoscopic surgeon with his trained team in our institute. Each case was evaluated in terms of age, sex, time required for the procedure, blood loss, and any other complications. After each case, operating surgeon was interrogated with respect to improvement in skill such as enclosopic suturing and experience about depth perception was recorded using Liker scale'. Surgeon's previous experience about the same procedure regarding time is considered to be the standard time required for the procedure. All the collected data were tabulated and master chart was prepared. Data were analyzed by using Statistical Package for the Social Sciences version 19.0.

RESULTS

In the present study, we operated total 3D cases using 3D technology. Most of the patients are between 21 and 30 years (about 33%) followed by 31–40 (about 30%) years age group. In present study, about 60% patients (n = 18) are male while 40% are female (n = 12). In the present study, seven cases of lap cholecystectomy, five cases of lap appendectomy, three cases of lap fundaplication, two cases of lap rectopexy, three cases of lap splenectomy,

two cases of transabdominal preperitoneal (TAPP), two cases of totally extraperitoneal (TEP), three cases of lap choledochoduodenostomy, and two cases of lap sleeve gastrectomy were done.

Lap. cholecystectomy and lap appendectomy are considered to be basic laparoscopic procedures. Moreover, lap fundoplication, lap rectopexy, TEP, TAPP, lap splenectomy, lap choledochoduodenostomy, and lap sleeve gastrectomy are considered to be advanced laparoscopic procedures. In the present study, we have operated 30 cases which included basic laparoscopy cases (n = 12, 40%) and advanced laparoscopy cases (n = 18, 60%).

In the present study, significant blood loss (>100 cc) has occurred in only 3 cases (10%).

Blood loss	No. of cases	% of total
>100 cc	3	10
<100 cc	27	90

In the present study, time required for the procedure is decreased, as compared to standard time, in 77% of cases (n = 23). Whereas time required for procedure, remained constant in 20% of cases (n = 6), and is increased in 3% of cases (n = 1).

Time required for Procedure	No. of cases	1% of total
Increased	1	3
Remains constant	6	20
Decreased	23	77

In the present study, only intraoperative complication was seen in only one case i.e. of splenectomy where injury to blood vessel has occurred that resulted in blood loss of about 500 cc. eventually bleeding was controlled with bipolar and rest of the procedure was uneventful.

Intraoperative complications	No. of Cases	% of cases
Yes	1	3
No	29	97
Total	30	100

In the present study, surgeons has agreed on improvement in skills such as endosuturing and knotting.

Depth perception	No. of cases	% of total
Superior	30	100
Equivocal	0	0
Inferior	0	0
Total	30	100

In the present study, we interrogated the surgeons about depth perception using 3D system after each case. Their remarks are noted on Likert's scale as superior, equivocal or inferior. We found that, in all the cases, surgeon experience superior depth perception using 3D system.

Improvement in skills	No. of Cases	% of cases
Yes	30	100
No	0	0
Total	30	100

DISCUSSION

The lack of stereoscopic vision on a 2D display causes visual misperceptions based on the loss of depth perception. The lack of depth perception and spatial orientation when using 2D imaging is a recognized limitation of laparoscopic surgery. This directly affects surgical performance, operative time, morbidity, and patients' post-operative quality-of-life.

Introduction of 3D imaging, has removed many of these technical obstacles. In present study, Olympus 3D system is used. In this system, two charge-coupled device image sensors are located at the distal end of the laparoscope to provide the left and right images, respectively. These two image signals are processed by a special-purpose video system to generate high-resolution 3D image. This image is then displayed on a 3D monitor and viewed through 3D glasses to provide realistic three-dimensional images.

In present study, we have operated 30 cases which included basic laparoscopy cases (n = 12, 40%) and advanced laparoscopy cases (n = 18, 60%).

We found that time required for the procedure has significantly decreased using 3-D system. More than 213° cases required less time for operation. Average time rquired for cholecysctectomy in the present study was 27.86 min (standard time is 30 min). While average time required for appendectomy was 23 min (standard time being 25 min). Average time required for lap fundoplication in present study is 65 min (standard time is 90 min). Average time required for lap splenectomy in the present study is 110 min (standard time being 120 min). In the present study, average time required for lap rectopexy is 60 min (while standard time being 90 min). Average time required for lap choledochoduodenostomy, in present study, is 120 min (standard time being 150 min). Whereas in the present study, average time required for lap sleeve gastrectomy is 80 min (standard time being 120 min). Our results are supported by study done by Bhayani and Andriole in this prospective study, 24 laparoscopists were evaluated on a validated and standardized laparoscopic task using both two-dimensional (2D) and 3D visualization systems. The time required for performing task of transferring the beads

from one container to another was significantly decreased (108 vs. 127 s, $P < 0.05$).[8]

In a study done by Bilgen *et al*.,[9] who compared time required for procedure using 2D and 3D. Twenty-two patients were included in the study. The mean performance time was 20.63 ± 5.66 and 30.0 ± 6.03 min in the Group A (3D) and Group B (2D), respectively ($P < 0.01$). They concluded that 3D imaging systems may cause a significant reduction in the performance time of laparoscopic cholecystectomy.

In the present study, only intraoperative complication was seen in only one case, that is, of slpenectomy where injury to blood vessel has occurred that resulted in blood loss of about 500 cc. eventually bleeding has been controlled using bipolar and rest of the procedure was uneventful. i.e. intraoperative complications are significantly reduced.

In the present study, surgeon has noticed significant improvement in skills such as endosuturing and knotting in all cases. This is supported by study done by Tevaearai *et al*. They found that 3–0 improves performance in pelvic trainer.

Study by Smith *et al*.[10,11] showed that stereoscopic projection technology (3D) significantly improves novice performance of minimally invasive surgical skills. Surgeons demonstrated a significant reduction in error rates for sequential repetitions of each task using the passive polarizing stereoscopic display compared with the 2D display. Mean errors for the 3D versus the 2D mode were 2.0 versus 4.3 for rope pass ($P = 5$ 0.001), 0.8 versus 1.6 for paper cut ($P = 0.001$), 1.3 versus 4L2 for needle capping ($P = 0.001$), and 2.8 versus 8.0 for knot tying ($P = {}^{5}0.001$). Novice surgeons demonstrated a significant improvement in mean time for completion for all four tasks when using the 3D system. Mean time (in seconds) for 3D versus 20 were 106.5 versus 134.4 for rope pass ($P = 5$ 0.001), 116.1 versus 176.3 for paper cut ($P =$ s 0.001), 76.3 versus 141.6 for needle capping ($P = {}^{5}$ 0.001) and 153.4 versus 252.6 for knot tying ($P = 5$ 0.001).

In the present study, we interrogated the surgeons about depth perception using 3D system after each case. Their remarks are noted on Likert's scale as superior equivocal or inferior. We found that, in all the cases, surgeon experience superior depth perception using 3-D system. According to the study done by Sahu *et al*.,[12] depth perception and hand eye coordination were excellent with 3D imaging system leading to accurate and swift dissection as well as better intra-corporeal knotting.

CONCLUSION

On the basis of results, we can conclude that surgeon found improved depth perception. Thus, 3D improves depth perception and thereby improves surgical performance of the surgeon. Time required for the procedure was significantly decreased as compared to standard more so ever in advanced laparoscopy cases. Thus, 3D significantly decreases time required for the procedure. Blood loss was found in significantly less number cases. Thus, 3–0 technology helps in minimizing blood loss. Furthermore, 3D technology helps in minimizing intraoperative complications. Surgeon found improvement in skills such as endosuturing and intracorporeal knotting. Thus, 3D improves skills of surgeon. All these features of 3D collectively helps to improve perioperative outcome and decreased hospital stay of patient.

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