

ORIGINAL ARTICLE

THE NEW GOLD STANDARD IN LAPAROSCOPIC IMAGING: 3D VS 4K LAPAROSCOPIC NEPHRECTOMY- A SINGLE CENTERED RANDOMIZED CONTROLLED TRIAL

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Background: Thanks to progressive technology and modern innovations, laparoscopic procedures, being minimally invasive, have now superseded upon most open surgical procedures. Laparoscopic procedures have proven advantages over open procedures. The study was designed to compare the outcomes of laparoscopic nephrectomy between 3D and 4K camera resolutions.

Methods: This randomized control trial carried out at Tabba Kidney institute, Karachi, Pakistan from July 2020 to April 2021, to our knowledge was the first of its kind comparative study in Pakistan and internationally. All patients diagnosed to have symptomatic non-functioning kidney on the basis of both renal scintigraphy and CT- KUB were divided through blocked randomization in to two different camera resolution groups, i.e., 3D vs 4K and outcomes in terms of operative time, haemoglobin fall, post procedure complications and in patient stay were recorded. **Results:** It was observed that the 3D group had a significantly shorter mean total operative time 172.1 ± 36.9 vs 272.5 ± 14.1 respectively ($p < 0.005$). A significant difference was also observed in mean operative time for task 2 was 53.1 ± 21.1 & 101 ± 30.9 mins ($p < 0.005$), and for task 3 was 67.18 ± 18.3 & 112.5 ± 37 mins ($p = 0.005$) for 3D and 4K groups respectively. The mean haemoglobin drops in 3D and 4K groups was 0.51 ± 1.6 & 0.73 ± 1.1 respectively ($p = 0.7$). Moreover, the mean hospital stay was 2.5 ± 0.6 for 3D group & 2.7 ± 0.9 for 4K group (p -value 0.8). Post-operative wound infection was observed in one patient in each group. No case had to be converted to surgery by an open approach. **Conclusion:** We concluded that despite being the latest technological advancement with a greater zooming capability, when used for performing laparoscopic nephrectomy, 4K imaging system couldn't show any superiority over 3D imaging system, in different operative tasks and in terms of total operative time.

Keywords: 3D imaging; 4K imaging; Nephrectomy; Operative time

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INTRODUCTION

The invention of television chip camera in early 1980s, led to a never-ending era of laparoscopy in the world of surgery.¹ Thanks to progressive technology and modern innovations, laparoscopic procedures, being minimally invasive, have now superseded upon most open surgical procedures. Laparoscopic procedures have proven advantages over open procedures: for instance smaller surgical incisions, less intra operative blood loss, less post-operative pain, shorter hospital stay, better cosmetic results, and early resumption of routine activities.² Technological advances in 1990s led to the introduction of three dimensional (3D) imaging systems.³ Initially, these imaging systems did not show any advantage over 2D laparoscopic imaging systems but with improvements in three dimensional systems, their clinical and surgical efficacy improved significantly.^{4,5} It is reported that urology is one of the most advanced specialties when it comes to modern

technology and the use of minimally invasive laparoscopic and endoscopic procedures. Though modern technology has enabled us to choose from a variety of imaging techniques that include 2D, 3D and 4K ultrahigh definition (UHD), literature comparing their efficacy during different surgical procedures still lags.⁶ Hitherto, a number of articles have been published comparing the use of 2D and 3D display systems in numerous surgical procedures, scarcely any are found in specialty of urology.^{2,7} Surprisingly, comparative study on the use of 3D and 4K UHD technology in laparoscopic nephrectomy is in almost negligible quantity. Most surgeons are of the view that the 3D systems are superior to conventional 2D HD systems as far as operative time is concerned as the former has immensely improved the stereoscopic depth perception but the efficacy of 3D against 4K UHD is yet to be determined.⁸⁻¹⁰ The rationale of conducting this study was therefore to compare the outcomes, i.e., haemoglobin fall, post-procedure complications, operative time and IPD stay of 3D and 4K

laparoscopic nephrectomy so that better of the two techniques could be opted in future.

MATERIAL AND METHODS

This randomized control trial was carried out from July 2020 to April 2021 in Tabba Kidney Institute, Karachi. Prior to commencement of the study an approval from the ethical review committee of Tabba Kidney institute was obtained (approval no. TKI-HEC 007). Inclusion criteria comprised of all patients aged 15–85 years, with a plan of nephrectomy. All patients included in the study were diagnosed to have symptomatic non-functioning kidney on the basis of both renal scintigraphy and CT- KUB. Those who were excluded had bleeding diathesis, chronic kidney disease, morbid obesity, prior renal surgery or major abdominal surgery, renal tumour/mass/malignancy, pregnancy and psychiatric illness. Eligible patients after written informed consents were divided through blocked randomization into two different camera resolution groups: 3D and 4K. Surgery was performed by an experienced surgeon. The outcomes in terms of haemoglobin fall, operative time, and IPD stay were evaluated. Complications were evaluated in the light of Clavein-Dindo classification. The surgical team comprised a single operating surgeon, assistant surgeon (camera person) and a scrub nurse. All 32 procedures were performed under general anaesthesia. Patients were catheterized prior to positioning in standard lateral kidney position. Three port retroperitoneal technique was used. In order to access the retroperitoneal space, 1 cm incision was made a cm below and anterior to the tip of 12th rib in lumbar triangle. After separating the subcutaneous tissues and dividing the underlying muscle fibres, retro peritoneum was accessed by gently traversing the thoracolumbar fascia. A balloon dilator was used in order to displace the adjacent adipose tissue and peritoneum to create an adequate working space. Retroperitoneum was then achieved by an insufflator which maintained the carbon dioxide pressure at 12–14 mmHg. A 10 mm port was then placed in the opening for use as camera port. Subsequent ports were then placed under direct vision, i.e., at renal angle (10 mm) and at iliac crest (5 mm) in case of left laparoscopic nephrectomy and at renal angle (5mm) and iliac crest (10mm) if right laparoscopic nephrectomy was to be performed. Posterior aspect of the kidney was then approached, gerota opened, renal hilum located and the hilar structures identified. Renal artery and vein were dissected free of fat and secured using Hem-o-lok clips on both proximal and distal ends of vessels [Figure-1 & Figure-2]. Once vascular control was achieved, the renal vessels were finally divided. The ureter was then clipped and divided. Subsequently, renal attachments were then bluntly dissected using a haemostatic dissector (ligasure®). Finally, the kidney was removed through extended camera port site, after it was fully mobilized. Retroperitoneal cavity was deflated of CO₂ before completing the procedure. Skin was closed using polypropylene sutures. The whole procedure was divided in to three operative tasks mentioned as follows

and the execution time for the entire procedure as well as individual tasks was recorded. First operative task: “From camera entry to identification of pedicle.” Included camera entry after achieving retroperitoneum and placing of all three ports. Approaching posterior aspect of the kidney. Opening gerota, locating renal hilum and identification of renal hilar structures. Second operative task: “Time taken for securing the pedicle.” Dissecting renal artery and vein free of surrounding tissues. Division of renal artery and vein after securing vascular control by application of Hemo-o-lok clips on both proximal and distal ends of vessels. Clipping and division of ureter. Third operative task: “Time taken for mobilizing the kidney.” Blunt dissection of renal attachments using a haemostatic dissector (ligasure®) till the kidney is fully mobilized and free of any attachment. The total time under discussion in the article is the sum of all three operative tasks, i.e., task 1 to 3. Statistical analysis was performed using the Statistical Package for Social Science (SPSS) software, version 23.0. All quantitative variables were expressed as the mean±standard deviation (SD). Frequencies and percentages were calculated for qualitative variables. Inferential statistics were explored using chi square test/unpaired t test and *p*-value ≤0.05 was taken as significant.

RESULTS

The mean age of study participants was 42.3±16.2. Out of 32 patients, 22(68.75%) were female and 10 (32.25%) males. The two groups were homogenous as shown in Table-1. The mean age of patients in 3D and 4K groups was 39.6±16.4 & 45.0±16.1 (*p*=0.31) while age range for 3D and 4K group participants was 48 & 47 years respectively. Table-1. Mean BMI of participants included in 3D and 4K groups was 24.7±1.3 & 26.0±1.4 respectively (*p*=0.58). Mean weight of resected specimen (kidney) in grams was 199.4±167.0 in 3D & 167.3±140.9 in 4K group, which was statistically insignificant (*p*=0.3). While comparing both the groups (3D & 4K), we observed that the 3D group had a significantly shorter mean total operative time 172.1±36.9 vs 272.5±14.1 respectively (*p*<0.005) Table-2. Concerning the individual operative times for task 1, 2 and 3, the mean operative time for task 1, i.e., from camera entry to identification of pedicle was 51.87±34.8 mins & 58.7±15.8 mins (*p*=0.52), for task 2, i.e., time taken to secure the pedicle was 53.1±21.1 & 101±30.9 mins (*p*<0.005), and for task 3, i.e., time taken for mobilizing the kidney was 67.18±18.3 & 112.5±37 mins (*p*=0.005) for 3D and 4K groups respectively. The mean haemoglobin drops in 3D and 4K groups was 0.51±1.6 & 0.73±1.1 respectively. Though the drop was lesser in 3D than the 4K group but was statistically insignificant (*p*=0.7). Mean hospital stay was 2.5±0.6 for 3D group & 2.7± 0.9 for 4K group. It too was statistically insignificant with a *p*-value of 0.8. Post-operative wound infection was observed in one patient in each group. While none of the cases were converted to surgery by an open approach.



Figure-1: Applying hem-o-lok clips on renal artery using 3D imaging system

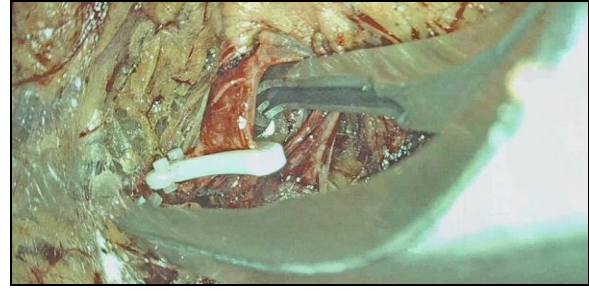


Figure-2: Applying hem-o-lok clips on renal artery using 4K imaging system

Table-1: Demographic details of study participants

Variable(s)	Total participants (n=32) Mean ±SD	3D (n=16) Mean±SD	4K (n=16) Mean±SD
Age in years, mean ±SD	42.3±6.2	39.6±16.4	45.0±16.1
Weight in Kgs, mean ±SD	59.7±12.6	59.3±12.4	60.1±13.2
BMI in kg/m ² , mean ±SD	17.7±5.6	24.7±1.3	26.0±1.40
Weight of resected kidney in grams, mean ±SD	183.35±153.95	199.4±167.0	167.3±140.9
Gender	n (%)	n (%)	n (%)
Male	10 (32.25)	4 (25)	6 (37.5)
Female	22 (68.75)	12 (75)	10 (62.5)

Table-2: Mean difference of operative time in between group

Operative Time (OT) Task, in minutes	3D (n=16) Mean±SD	4K (n=16) Mean±SD	p-value
Task 01	51.87±34.8	58.7±15.8	0.52
Task 02	53.1±21.1	101±30.9	<0.005
Task 03	67.18±18.3	112.5±37	<0.005
Total Operative Time	172.1±36.9	272.5±14.1	<0.005

Table-3: Mean difference of quantitative variables in between groups

Variable(s)	Total participants (n=32) Mean ±SD	3D (n=16) Mean ± SD	4K (n=16) Mean ± SD	p-value
Haemoglobin drops	0.62±1.3	0.51±1.6	0.73±1.1	0.701
Haematocrit Drop	5.71±9.2	5.4±10.1	6.0±8.75	0.832
Hospital stays	2.6 ±0.7	2.5±0.6	2.7±0.9	0.100

DISCUSSION

This study was carried out in one of the most advanced renal care institutes of Pakistan with an aim to compare the outcomes of 3D versus 4K laparoscopic nephrectomy among patients with symptomatic non-functioning kidney. The outcomes studied were haemoglobin fall, post-procedure complications, operative time and hospital stay. The findings of the study revealed that the 3D group had a considerably shorter mean total operative time as compared to 4K imaging. Though mean operative time for task 1 (from camera entry to identification of pedicle) was shorter in 3D group but was statistically insignificant. The mean operative time for task 2 (time taken to secure the pedicle), task 3 (time taken for mobilizing the kidney) and total operative time (including all the tasks) was shorter in 3D group and was statistically significant. Similar findings were reported in a previous study by Bilgen *et al* as well in

which it was reported that 3D laparoscopic systems shortened the operative time for laparoscopic cholecystectomy.¹¹ On the contrary a study conducted by Dunstan *et al* revealed that a 3D system does not reduce operative time during laparoscopic cholecystectomy when compared to a 4K system.¹² The contradiction in results might be due to the fact that cholecystectomy, a comparatively simpler procedure, is performed in peritoneal cavity where working space is much greater than that in retroperitoneum. In addition to that, laparoscopic nephrectomy itself is a complex procedure especially in the presence of infective adhesions surrounding a non-functioning inflamed kidney. 3D laparoscopic systems might not be as beneficial in terms of operative times in simple procedures as they are in complex ones is another question that comes to mind when comparing our results with those of above-mentioned study. Another retrospective study by Tang *et al* comparing 3D versus 2D laparoscopy for

radical cystectomy and pelvic nodes dissection supported our study findings and concluded that 3D laparoscopic cystectomy was significantly advantageous in terms of operative time, lymph node dissection and total operative time. It is worth mentioning here that lap radical cystectomy and pelvic lymph node dissection is a complex procedure unlike cholecystectomy.

Haemoglobin drop-in 3D group as compared to 4K group was lower but was not statistically significant. The finding was also supported by a study conducted by Agrusa *et al* in which the authors reported no significant difference blood loss in any imaging technique.¹⁴

Similarly, a non-significant decline in the mean length of hospital stay was observed in the 3D group as compared to 4K group, though, no previously published study was found on the subject that reported hospital stay. However, Yoon *et al* in their study on laparoscopic colectomy reported no significant difference in the mean hospital stay in 3D compared to 2D group.¹⁵

In the current study, it was noticed that secondary to extensive adhesions, there was an occurrence of tear to psoas muscle in 3D group while an injury to adrenal gland leading to ipsilateral adrenalectomy in 4K group. One patient in each group had a post-operative wound infection, classified as grade I according to Claven- Dindo score. No case had to be converted to surgery by an open approach. Surgeon felt the need for drain placement in 26 out of 32 patients of which 12 belonged to 3D group whereas 14 to 4K group. Moreover, the surgeon and assistant surgeon, assistant nurses and anaesthetists all reported a better identification of anatomic structures and a better depth perception while using 3D imaging system.

There were 2 more patients in 4K group who needed drain placement. We couldn't sort out any specific reason behind this. Most of the time it's surgeon's preference as some surgeons place a drain for safety reasons as a precautionary measure. The number might have been different if the procedures were carried out by some other surgeon.

As far as complications were concerned, both the groups showed similar results and it could not be determined whether any of the group had superiority over the other as in addition to a case of wound infection in each group, there was an occurrence of tear to psoas muscle in 3D group while an injury to adrenal leading to ipsilateral adrenalectomy in 4K group. No other intra operative or post-operative complications occurred in either group.

A limitation of the study was its small sample size. It is necessary to conduct further

randomized trials to compare both the imaging systems with a greater number of subjects and that too with participation of multiple surgeons having different levels of experience, which due to our limited resources was not possible. Furthermore, high quality studies are required comparing the outcomes of not only 3D and 4K imaging systems but also 2D and 4K technologies in a variety of surgical procedures especially complex ones, to better determine their efficacy.¹⁶

CONCLUSION

So, we conclude that despite being the latest technological advancement with a greater zooming capability, when used for performing laparoscopic nephrectomy 4K imaging system couldn't show any superiority over 3D imaging system, in different operative tasks and in terms of total operative time.

AUTHORS' CONTRIBUTION

NSK: Objective, data entry, surgery. SS: Surgery, final approval of manuscript. JS: Surgery, data analysis. AA: Write-up. HA: Write-up. SSQ: Randomization. ME: Data entry

REFERENCES

1. Al-Kandari A, Ganpule AP, Azhar RA, Gill IS, editors. Difficult conditions in laparoscopic urologic surgery. Springer; 2018.
2. Hanna GB, Shimi SM, Cuschieri A. Randomised study of influence of two-dimensional versus three-dimensional imaging on performance of laparoscopic cholecystectomy. *Lancet* 1998;351(9098):248–51.
3. Yazawa H, Takiguchi K, Imaizumi K, Wada M, Ito F. Surgical outcomes of total laparoscopic hysterectomy with 2-dimensional versus 3-dimensional laparoscopic surgical systems. *Fukushima J Med Sci* 2018;64(1):38–45. Tang FJ, Qi L, Jiang HC, Tong SY, Li Y. Comparison of the clinical effectiveness of 3D and 2D imaging systems for laparoscopic radical cystectomy with pelvic lymph node dissection. *J Int Med Res* 2016;44(3):613–9.
4. Kunert W, Storz P, Kirschniak A. For 3D laparoscopy: a step toward advanced surgical navigation: how to get maximum benefit from 3D vision. *Surg Endosc* 2013;27(2):696–9.
5. 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;11(5):438–40.
6. Storz P, Buess GF, Kunert W, Kirschniak A. 3D HD versus 2D HD: surgical task efficiency in standardised phantom tasks. *Surg Endosc* 2012;26(5):1454–60.
7. Wagner OJ, Hagen M, Kurmann A, Horgan S, Candinas D, Vorburger SA. Three-dimensional vision enhances task performance independently of the surgical method. *Surg Endosc* 2012;26(10):2961–8.
8. Serrano OK, Bangdiwala AS, Vock DM, Berglund D, Dunn TB, Finger EB, *et al*. Defining the tipping point in surgical performance for laparoscopic donor nephrectomy among transplant surgery fellows: A risk-adjusted cumulative summation learning curve analysis. *Am J Transplant* 2017;17(7):1868–78.
9. Wahba R, Datta RR, Hedergott A, Bußhoff J, Bruns T, Kleinert R, *et al*. 3D vs. 4K Display System-Influence of “State-of-the-art”-Display Technique On Surgical

- Performance (IDOSP-Study) in minimally invasive surgery: protocol for a randomized cross-over trial. *Trials* 2019;20(1):1–8.
10. Bilgen K, Üstün M, Karakahya M, Isik S, Sengül S, Çetinküner S, *et al.* Comparison of 3D imaging and 2D imaging for performance time of laparoscopic cholecystectomy. *Surg Laparosc Endosc Percutan Tech* 2013;23(2):180–3.
 11. Cicione A, Autorino R, Breda A, De Sio M, Damiano R, Fusco F, *et al.* Three-dimensional vs standard laparoscopy: comparative assessment using a validated program for laparoscopic urologic skills. *Urology* 2013;82(6):1444–50.
 12. Aarts JW, Nieboer TE, Johnson N, Tavender E, Garry R, Mol BW, *et al.* Surgical approach to hysterectomy for benign gynaecological disease. *Cochrane Database Syst Rev* 2015;8:CD003677.
 13. Ridgeway B, Falcone T. Innovations in minimally invasive hysterectomy. *Clin Obstet Gynecol* 2014;57(1):83–94.
 14. Gurusamy KS, Sahay S, Davidson BR. Three dimensional versus two-dimensional imaging for laparoscopic cholecystectomy. *Cochrane Database Syst Rev* 2011;1:CD006882.
 15. Bilgen K, Üstün M, Karakahya M, Isik S, Sengül S, Çetinküner S, *et al.* Comparison of 3D imaging and 2D imaging for performance time of laparoscopic cholecystectomy. *Surg Laparosc Endosc Percutan Tech* 2013;23(2):180–3.
 16. Dunstan M, Smith R, Schwab K, Scala A, Gatenby P, Whyte M, *et al.* Is 3D faster and safer than 4K laparoscopic cholecystectomy? A randomised-controlled trial. *Surg Endosc* 2019;18:1–7.

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