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Three-dimensional (3D) versus two-dimensional (2D) laparoscopic adrenalectomy: A case-control study

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ABSTRACT

Introduction: Laparoscopic adrenalectomy is today considered the gold standard of treatment for adrenal tumors. The development of high definition cameras does not eliminate the major limitation of two-dimensional (2D) laparoscopy: lack of depth perception and loss of spatial orientation. Tree-dimensional (3D) HD laparoscopy was developed as an alternative to conventional 2D laparoscopy.
Methods: We report our experience with use of 3D vision system for laparoscopic adrenalectomy. Between January 2009 and March 2015 we performed a total of 52 laparoscopic adrenalectomies. In this case-control study we considered 13 laparoscopic adrenalectomies performed with three-dimensional (3D) vision system as case group. The last 26 procedures made with two-dimensional (2D) HD laparoscopic system represented the control group. We considered primary end-points: operative time, intraoperative complications and conversion rate. We evaluated also quality of depth perception and surgical strain.
Results: Although the operative time for the entire surgical procedure was shorter in 3D group, there were no significant differences. The surgeon experienced better depth perception with 3D system and subjectively reported less strain using 3D vision system. Residents and medical students confirmed these data on surgical outcome.
Conclusion: 3D system vision does not seem to influence the operative time of laparoscopic adrenalectomy performed by experienced surgeon because the surgical technique request simple tasks. We obtain the better visualization in depth perception with effect on surgical precision. Comparative studies are necessary to verify if 3D can reduce perioperative complication with similar operative time.

1. Introduction

Laparoscopic adrenalectomy is today considered the gold standard of treatment for bening adrenal tumors. This technique was described for the first time by Gagner in 1992 [1] and in the past years several studies have shown the advantages of laparoscopic approach [2] with decrease of the perioperative morbidity, lower complication rates, less operative blood loss, less postoperative pain and shorter hospital stay compared with open adrenalectomy [3]. On the contrary there are several doubts about laparoscopic approach in case of adrenocortical carcinoma [4,5]. However, laparoscopic surgery is more difficult to learn and requires different psychomotor skills than open laparotomy. In fact, the surgeons have to work in a three-dimensional space, but are guided by two-dimensional images [6]. The development of high definition cameras does not eliminate the major limitation of two-dimensional (2D) laparoscopy: lack of depth perception and lose of spatial

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orientation with potential increasing the strain for the surgeon, the risk of errors and the operative time. Three-dimensional (3D) HD laparoscopy was developed as an alternative to conventional 2D laparoscopy [7]. Although 3D technology was introduced in the early 1990s its equipment is still not standard in hospital because of initial observation of side effects when using 3D vision systems, poor image resolution and more expensive cost [8]. In literature there are still few clinical studies on use of 3D with different results [9]. In this study we report our experience with use of 3D vision system for laparoscopic adrenalectomy.

2. Methods

2.1. Patients selection

In our Department of General and Emergency Surgery at the University Hospital Policlinico "P. Giaccone" of Palermo between January 2009 and March 2015 we performed a total of 52 laparoscopic adrenalectomies. In this case-control study we considered 13 laparoscopic adrenalectomies performed with three-dimensional (3D) vision system as case group. The last 26 procedures made with two-dimensional (2D) HD laparoscopic system represented the control group [10]. The 2D imaging system consisted of KARL STORZ 2D/HD system equipped with a 30° direction of view and 10 mm diameter laparoscope and the 3D imaging system was KARL STORZ 3D Camera System (Karl Storz, Tuttlingen, Germany) equipped with a 30° direction of view and 10 mm diameter laparoscope and a 3D camera control unit for the transmission of 3D signals to a HD 3D monitor.

2.2. Surgical technique

In both two group we used the same standard surgical technique. Laparoscopic adrenalectomies were performed by a transperitoneal flank approach in the lateral decubitus position with an inclination of 50–60° relative to the operating table which is broken to extend the space between the last rib and the iliac crest [11]. We used Veress needle to induce pneumoperitoneum. For right adrenalectomy we used four trocars in the right subcostal region. The right lobe of the liver is mobilized by division of triangular ligament. Than the peritoneum overlying the right adrenal gland, in Albarran-Chatelin space, is dissected using harmonic scalpel. Tissue dissection along the lateral border of the inferior vena cava allowed the identification of the short adrenal vein which was clipped and divided. Then, by dissecting from medial to lateral and from inferior to superior the gland was mobilized until it was completely free. For left-side resection we positioned three trocars in the left subcostal region. We divided splenocolic and splenophrenic ligament. The spleen and pancreatic tail were rotated medially. The peritoneal dissection was performed until the left renal vein is reached. We used also diaphragmatic vein like landmarks for adrenal vein which was clipped and divided. The resection then proceeded as previously described for the right adrenal gland [12,13].

2.3. Evaluation of surgical outcome

We used 3D system for the first time in November 2012 for laparoscopic cholecystectomy and, in the last two years, we carried out also appendectomies, gynecological surgery, colo-rectal resections, upper GI surgery, splenectomies and radical and sparing renal surgery [14–17]. In this study we analyzed only the laparoscopic adrenalectomy for some reasons:

- particular "deep" location of adrenal loggia with theoretical maximum advantage of a 3D system;
- surgical technique that do not request suturing, intra-corporeal knotting or other difficult surgical tasks [18].

We considered like primary end-points operative time, intraoperative blood loss and other complications, conversion rate [19]. These parameters are direct objective signs of surgical precision. In this case differences between the two groups for variable were determined by x^2 exact test and Student *t* test. Statistical significance was considered $P < 0.05$. We considered also other subjective variables with use of a questionnaire for surgical team with the scope of evaluate quality of depth perception and surgical strain. The variables analyzed for surgical outcome were: precision, definition of planes and depth perception. The variables for surgical strain were: wrist and hand strain, back strain, neck strain and eye strain [20]. In our University Hospital we also administered a modified questionnaire for measuring surgical outcome and personal interest of a total of 30 residents and medical students during live surgery sessions.

3. Results

The two groups were similar for age: mean 54.2 years (range 38–74) in the 2D group versus mean 55,8 years (range 42–72) in the 3D group, and gender (17 male and 9 female, ratio 1.8:1 vs 8 male and 5 female, ratio 1.6:1). Although the operative time for the entire surgical procedure was shorter in 3D group, there were no significant differences (mean 120 min, range 100–240 in 2D group vs mean 110 min, range 100–210 in 3D group). In the 2D group in a case of left adrenalectomy we registered intraoperative complication with bleeding from spleen injury and in another case we observed a discrete diffuse bleeding from peri-renal tissue. However, there were no significant differences in terms of intraoperative blood loss. No conversion to open surgery was necessary (Table 1) We reported none postoperative complications in both group. The surgeon experienced better depth perception with 3D system and subjectively reported less strain using 3D vision system rather than 2D system, in particular during longer procedures. Residents and medical students confirmed these data on surgical outcome and affirmed that 3D laparoscopic vision increased their personal interest for surgical procedures. In nine cases we registered negative effects of 3D vision like headache and dizziness because of the time necessary for adaption to the stereo effect [21] (Table 2).

4. Discussion

Although 3D vision technology for laparoscopy has substantially improved it is still not the common standard for laparoscopic surgery [22]. This vision system allows to obtain a better visualization in deep and small spaces like adrenal loggia and in particular during adrenal vein isolation [23,24]. The surgical team stressed this concept in the results of questionnaire and reported subjectively more accurate performance. This study did not show significant operative time differences using 3D HD imaging when compared with 2D HD vision system. In recent studies 3D visualization was found to reduce operative time. Most of these studies have been conducted using an experimental surgical model [19,25]. A recent review reported a lower rate (63% of the trials) of errors with the use of 3D system [9,26]. Storz P. et al. [25] concluded that the use of 3D might be of minor importance in simple tasks, but it can increased task efficiency when performing difficult surgical tasks. In accord with Navarra et al. [20] we can explain our results on the basis of surgical technique for laparoscopic adrenalectomy, that do

Table 1
Patients data of case-control study.

	2D laparoscopic group	3D laparoscopic group
Mean operative time	120 min (range 100–240)	110 min (range 100–210)
Gender (M: F)	Ratio 1.8: 1	Ratio 1.6:1
- Male	17	8
- Female	9	5
Mean Age (years)	54.3 (range 38–74)	55.8 (range 42–72)
Side	15	8
- Right side	11	5
- Left side		
Intraoperative complication	2	–
Conversion	–	–

Table 2
Parameters of evaluation of surgical team and residents and medical student during live surgery sessions.

Surgical team parameters	Mean score after 2D group	Mean score after 3D group	p-value
Variables of surgical outcome[a]	3.8 (range 3–4)	4.2 (range 3–5)	<.05
- Precision	3.1 (range 2–4)	4.5 (range 4–5)	<.05
- Definition of planes	2.8 (range 2–4)	4.5 (range 4–5)	<.05
- Depth perception			
Variables of surgical strain[b]	3.2 (range 2–4)	3.1 (range 2–4)	NS
- Wrist and hand strain	1.9 (range 1–4)	1.7 (range 1–3)	NS
- Neck and back strain	3 (range 2–4)	2.6 (range 2–4)	NS
- Eye strain	1	1.5 (1–2)	NS
- Dizziness and/or headache			
Residents and medical students			
Variables of surgical outcome[a]	2.2 (range 2–4)	4.5 (range 4–5)	<.05
- Precision	2.1 (range 2–3)	4.6 (range 4–5)	<.05
- Definition of planes	1.6 (range 2–4)	4.7 (range 4–5)	<.05
- Depth perception			
Variables of surgical strain[b]	–	–	NS
- Wrist and hand strain	–	–	<.05
- Neck and back strain	3.5 (range 2–4)	2.8 (range 2–4)	
- Eye strain	–	1.2 (1–2)	
- Dizziness and/or headache			
What is your interest for the surgery?[c]	3.2 (range 1–5)	4.1 (range 2–5)	<.05

[a] Variables of surgical outcome: score 1–5; 5 = excellent.
[b] Variables of surgical strain: score 1–5; 1 = no strain.
[c] Question only for medical students.

not request suturing, intracorporeal knotting or other difficult surgical tasks. Furthermore, experienced surgeons can overcome the limitations of 2D vision by memory of repetitive tactile information. Before starting this study our surgical team performed several 3D laparoscopic procedures like cholecystectomies and appendectomies in order to attenuate the effect of learning curve. So, we learned to use 3D monitor in the "stereopsis comfort zone" [27] that is different when compared with 2D laparoscopic monitor. Objects that are too close and those that are too far cause uncomfortable retinal rivalry areas and might to be responsible of dizziness and/or headache [28,29]. 3D laparoscopic vision increased interest for surgical procedures by residents and medical students. 3D equipment reduces operating or training time for new surgeons.

5. Conclusion

On the basis of our preliminary results 3D system vision does not seem to influence the operative time of laparoscopic adrenalectomy performed by experienced surgeon because the surgical technique request simple tasks. We obtain the better visualization in depth perception with effect on surgical precision. Comparative studies are necessary to verify if 3D laparoscopy can reduce perioperative complications with similar operative time. Actually we study the effects of 3D laparoscopic vision in upper GI surgery (intervention for esophageal achalasia and hiatal hernia) with suturing and intracorporeal knotting. Recent studies demonstrate that the side effects associated with 3D laparoscopy are less common when using the newest technology [30]. However a 3D view can be essential in medical education for communicating endoscopic anatomy and surgical training [31].

Conflicts of interest

Agrusa Antonino and other co-authors have no conflict of interest.

Sources of funding

Agrusa Antonino and other co-authors have no study sponsor.

Ethical approval

Not required.

Author contribution

Agrusa Antonino: study design and writing.
Di Buono Giuseppe: study design, data collections, data analysis and writing.
Daniela Chianetta: data collections and data analysis.
Sorce Vincenzo: data collections and data analysis.
Citarrella Roberto: data collections and data analysis.

Galia Massimo: data collections and data analysis.
Vernuccio Laura: data collections and data analysis.
Romano Giorgio: study design and writing.
Gulotta Gaspare: study design.

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