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The effectiveness of a live animal model in a laparoscopic partial nephrectomy for renal cancer training – a survey study

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Introduction. A laparoscopic partial nephrectomy for kidney cancer is a technically demanding procedure. Among many training approaches a live animal model is considered to be one of the most promising.

Material and methods. During nine editions of a two day live animal laparoscopy course, nine urologists took part in exercises aimed at mastering a partial nephrectomy for kidney cancer. After finishing the courses, an online survey was sent to all participants in order to evaluate the practical implications of the training on a live animal model.

Results. Seven participants responded to the survey. Two attended one course, two attended two courses and three attended more than twice. The number of partial nephrectomies performed during the course ranged from 0 to 20. All participants declared good understanding of the knot formation and stated that they use their obtained knowledge on a regular basis. Six of seven participants would like to repeat the course. All participants would recommend this course to colleagues with no partial nephrectomy experience.

Discussion. A live animal laparoscopy course for experienced urologists can yield positive results in terms of technical abilities and the implementation of minimally invasive techniques into clinical practice. It seems that this type of advanced simulation is better for clinicians than residents. The high level of satisfaction and willingness to repeat the course seem to back up this hypothesis.

Conclusions. The live animal model seems to be an interesting tool in advanced training in minimally invasive partial nephrectomy for kidney cancer.

Key words: laparoscopy, partial nephrectomy, animal model, minimally invasive surgery

Introduction

A laparoscopic nephrectomy, simple or radical, has become the standard approach to nephrectomy as it has been shown to minimize morbidity without compromising the longer-term outcomes [1].

A laparoscopic partial nephrectomy is recommended for patients with tumors less than 7 cm in diameter, considering renal parenchyma spearing approach if only anatomically possible and oncologically accurate [2].

It is well-established that oncologic safety and long-term results in patients undergoing a partial nephrectomy is superior to nephrectomy in carefully selected renal cancer patients [3]. With the advancement of modern diagnostic tools and screening programs, more and more patients can be schedu-

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led for a minimally invasive surgical (MIS) partial nephrectomy approach. Despite the fact of the rapid introduction of the robotic technique, still the most common MIS approach to a partial nephrectomy is a laparoscopy.

In a study by Boga et al., no significant differences were observed in eGFR changes and post-operative new-onset chronic kidney disease 1 year after surgery ($p = 0.768$, $p = 0.614$, respectively) during the overall mean follow-up period of 36.07 ± 13.56 months ($p = 0.007$). During the follow-up period, there were no cancer-related death observed in both groups and non-cancer-specific survival was 93.5% and 94.4% in the laparoscopic and robotic groups, respectively ($p = 0.859$) [4]. The main problem inherent in the laparoscopy approach to a partial nephrectomy is the level of technical difficulty of the operation [5]. In order to adequately prepare surgeons for this demanding operation, different modalities were introduced into the training curriculum including silicone-based models [6]. Different animal models were proposed for the MIS training in urology [6]. Live anesthetized animals are a well established model for the laparoscopic training and obtaining complex skills by the minimally invasive surgeons [7, 8]

However, there is a lack of evaluation of feedback from the participants of the different training approaches and therefore it can be difficult to assess the value of this type of training. In this study, we analyzed the subjective impact of training in a laparoscopic partial nephrectomy using a live porcine model.

Material and methods

Study setting and design

A survey-based observational study was performed. The study participants were recruited from Polish urologists, who participated in two days hands-on training course in laparoscopic urology. Training was held in the Jesús Usón Minimally Invasive Surgery Centre, Cáceres, Spain. The program of the course contained lectures, dry lab training, tissue model and a live anesthetized animal model. There were nine editions of the course. All participants were actively practicing specialists in urology.

Tutors

The tutors who participated in the study (surgeons and veterinary surgeons) had experience in both theoretical activity and practical mentoring during animal MIS procedures, participating in at least five hands-on courses as mentors. The same lectures and basic training exercises were given to all participants. Advanced exercises were adapted to the previous experience of the participants and a tailored approach was chosen for the intracorporeal suturing exercise.

Exercises

Before proceeding to the animal model, the participants underwent a step-by-step training program, including lectures, practical skills teaching, and intracorporeal suturing. The suturing was done in the *ex-vivo*, a preserved porcine small intestine inside a plexiglass training box. The main focus was on the formation of the intracorporeal node at different angles and under stressful conditions.

Animal model

The porcine species is used as the experimental model for urological laparoscopy training because of its anatomical similarities in the position and structure of the kidneys to the human urinary tract. At the beginning of the procedure, the animal is positioned on the back for the first trocar introduction and obtaining a pneumoperitoneum with the assistance of the Veress needle. The features of the anatomy of the anterior abdominal wall of the pig can cause sliding of the trocar between the layers and cause insufflation outside the abdominal cavity. To allow for partial nephrectomy on both sides of the animal, we put the first 10 mm optical trocar 1 cm above the umbilical scar. Then pneumoperitoneum pressure is set to 12 mm Hg. All animals undergo standard pre-op and intraoperative medication.

Working ports positions are as follows: subcostal 10 mm trocar for the scissors, needle holder and energy source instruments for the right hand. For the left hand 5 mm trocar in the iliac fossa, to handle the dissector or grasping forceps. A 5 mm trocar is placed in the flank, for the forceps and the aspirator. After positioning of the trocars, the animal is rotated to the side in a lateral position with lumbar elevation for the viscera shifting and better renal exposure. The final position of the animal and the operating team is shown on figure 1.

A peritoneal excision is done from the posterior side at the height of the ureter and caudal pole of the kidney with the monopolar L-hook. Using the forceps or aspirator, the caudal pole of the kidney is retracted for the pedicle exposure and manipulations. The renal artery is then dissected, and a vessel silicone tourniquet is prepared to be applied, as shown in figure 2.

The renal vein is dissected to achieve confidence of vascular damage control by the participants. Once it is achieved, the operating surgeon marks the incision line with the monopolar coagulation. Afterwards two clips are applied on

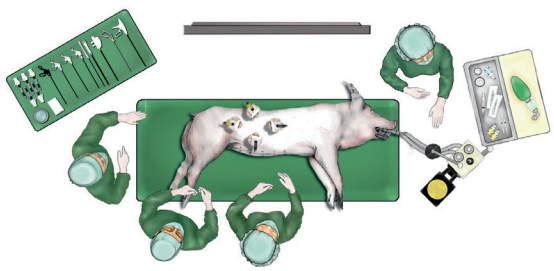

Figure 1. Position of the team and the animal (illustration from the *Manual de Formación en Cirugía Laparoscópica Paso a Paso*, Caceres 2013, with permission)

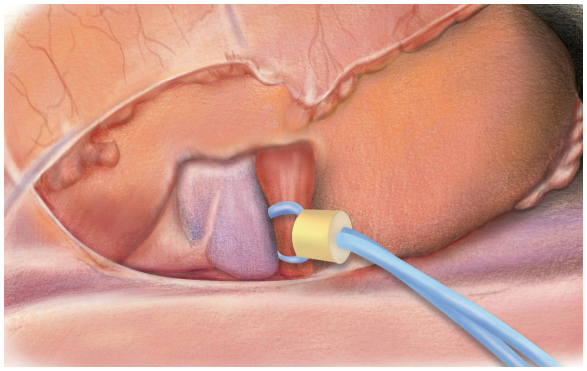

Figure 2. Silicone tourniquet application (illustration from the *Manual de Formación en Cirugía Laparoscópica Paso a Paso*, Caceres 2013, with permission)

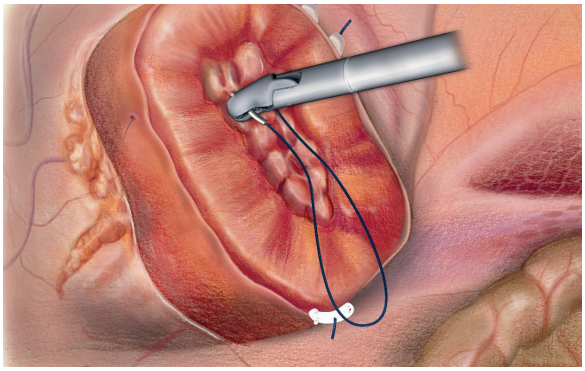

Figure 3. Final steps of the procedure (illustration from the *Manual de Formación en Cirugía Laparoscópica Paso a Paso*, Caceres 2013, with permission)

the tourniquet to obtain arterial occlusion and the timer is set. The parenchyma of the kidney is transected without energy use with the laparoscopic Metzenbaum scissors. Once the excision is completed, hemostasis of the bed is performed. Kidney reconstruction is performed with the 3–0 polyglactin absorbable sutures using hemostatic gauze, as shown in figure 3. Then tourniquet is removed by cutting one part of the loop.

After finishing a partial nephrectomy, three working ports are removed from the abdomen under direct vision and trocar wounds are sutured. Then, the animal is placed in the contralateral position by the technical team for the exposure of the second kidney and the position of working ports are inverted. During the change of position, an ex-suflation is performed, promoting the control of the hemostasis. The procedure site is examined after re-establishing the pneumoperitoneum.

Survey

The anonymous questionnaire was sent to participants at least 12 months after finishing the course. There were five demographical questions and 13 questions regarding the course and its effect on clinical practice. The detailed questionnaire can be seen in table I. The questionnaire was sent to the participants through the Google forms (Google LLC, 1600 amphitheatre parkway mountain view CA 94043).

Table I. List of questions regarding training in laparoscopic partial nephrectomy used in the survey

	Question	Answer
1	full name	
2	age	
3	position	resident
		medical doctor
		chief specialist/ chief of the department
		other
4	How many times have you been on our course in Caceres?	once
		two times
		more than two times
5	date of the training in Caceres (year, month)	
6	How many partial nephrectomies have you performed on a tissue model? (please mention the number)	
7	How many partial nephrectomies have you performed on a live animal model as an operating surgeon? (please mention the number)	
8	How many partial nephrectomies have you performed on a live animal model as an assisting surgeon? (please mention the number)	
9	How do you evaluate the training for partial nephrectomy in Caceres on animal tissue from 1 (completely useless) to 10 (the best I can imagine)?	completely useless the best I can imagine
10	Do you feel you were ready to perform laparoscopic partial nephrectomy in humans after attending training?	not ready
		prepared but definitely needing more training
		prepared but needed some assistance
		well prepared

Table I. cont. List of questions regarding training in laparoscopic partial nephrectomy used in the survey

	Question	Answer
11	Have you done partial laparoscopic nephrectomy after our course?	yes
		no
12	Did you have intracorporeal suturing skills and knot tying capabilities before taking part in the training course?	
		yes
		no
		other
13	Did you use your obtained knowledge, tips, and tricks in intracorporeal suturing and knot tying in the operating room after the training course?	
		yes
		no
14	Would you like to participate again in such a course?	yes
		no
		maybe
15	How many partial nephrectomies did you perform before the course? (please mention number)	
16	How many partial nephrectomies did you perform after the course? (please mention number)	
17	Would you recommend this course for colleagues with no partial nephrectomy experience?	yes
		no
18	Would you advocate this course for colleagues wanting to master partial nephrectomy technique?	yes
		no

Results

The questionnaire was sent to nine participants. Seven participants (77%) returned the filled form. All those that responded, responded to all questions in the questionnaire. The age of the participants was within the range 45–54 years (mean 49 years). All participants were male. Six participants were medical doctors, and one – a Chief specialist/ Chief of the department. Two attended training course in Caceres once, another two twice, and three participants participated more than twice. The number of partial nephrectomies that were done on the tissue model ranged from 0 (one result) to 20 (one result), the latter figure seems highly unlikely given the overall number of nephrectomies performed. Other participants mention 1 (one result), 2 (two results), and 3 (one result), this result seems more likely to be true. One participant forgot the exact number of procedures performed on the model, mentioning one or two attempts. The number of operations performed on the live animal model as an operating and assisting surgeon are presented in table II.

Five participants declared that before attending the training course they did not have a clear understanding of intracorporeal knots formation in laparoscopic surgery. After the course, all seven participants declared a good understanding of the sequence of knot formation and the steps required to increase quality and performance in intracorporeal knot tying.

Table II. Number of cases performed on a live anesthetized animal model

How many partial nephrectomies have you performed on a live animal model as an operating surgeon?	How many partial nephrectomies have you performed on a live animal model as an assisting surgeon?
1	1
0	0
1 or 2	1 or 2
2	3
0	1
10	10
2	3

All seven participants mentioned that they use their obtained knowledge, tips, and tricks in intracorporeal suturing and knot tying in the operating room after the training course on a regular basis. The number of procedures performed by the participants in their home hospitals are presented in figures 4 and 5.

Six of seven participants declared their wish to return for this type of training course in the future. Seven participants agreed on the statement to recommend this course to colleagues with no partial nephrectomy experience. Six of the seven

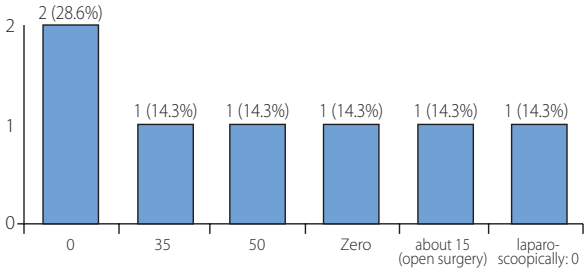

Figure 4. Number of partial nephrectomies performed before attending the course

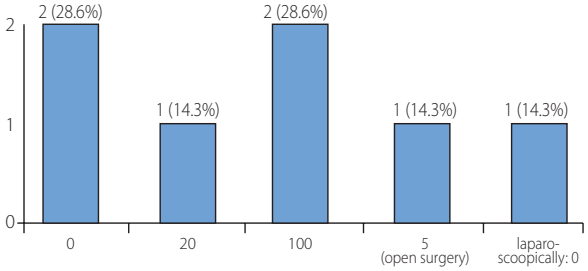

Figure 5. Number of partial nephrectomies performed after attending the course

participants agreed to advocate this course for colleagues willing to master partial nephrectomy laparoscopic technique.

Discussion

Minimally invasive surgery permeates all branches of surgery urology included. It is common to study the basics of minimally invasive surgery during residency, but there are no clearly established mandatory programs that would guarantee a high-quality result and implementation of minimally invasive operations into clinical practice for more senior surgeons. There is also still a large number of surgeons who completed their training long before the widespread introduction of minimally invasive technologies. Overall, the literature describes a large number of studies on the skills of residents after completing short-term courses, but little attention is paid to courses for more senior colleagues.

Among the population of young specialists, hands-on training is quite popular. Some studies show great satisfaction of participants with all of them willing to recommend hands--on training to other residents, considering it an important stepping stone in their career [10]. Some authors showed improvement, not only in the task performance by residents and students, but even an increased interest in their surgical specialty due to this minimally invasive course [11].

Unlike residents, senior specialists could implement new surgical interventions immediately after completing a training course without delay. At the beginning of the learning curve, this could be a negative factor for the quality of performance. If this statement is indeed true, the training of senior specialists should become a priority in the structure of postgraduate education.

In a urology setting, one of the most common indications for the minimally invasive approach is nephron sparing surgery [12]. Laparoscopic partial nephrectomy is recommended for patients diagnosed with kidney tumors less than 7 cm in diameter. The anatomical location of the tumor has got to be taken into account as well [2].

The laparoscopic partial nephrectomy is highly demanding in terms of surgical performance [5]. To obtain the required technical skills, many training approaches can be proposed including live animal models [6]. While evaluation of the learned skills is fairly common, the real impact of such courses on clinical practice is unknown. In this paper we tried to determine whether live animal model training had any impact on clinical practice of urologists specializing in urologic oncology. While data obtained in our survey is limited, it seems to back up the statement that an animal model in training for laparoscopic partial nephrectomy for kidney cancer is well received by experienced clinicians. It seems that the implementation of short duration intensive training can be beneficial in starting minimally invasive programs at urology departments.

One of the most praised elements of the course was intracorporeal knot tying. It is clear that intracorporeal suturing should be included in all minimally invasive training programs, including partial nephrectomy training courses. This is especially true when we realize that laparoscopic suturing and knot tying are technically challenging and failure to tie a knot can lead to conversion to open procedure [13]. Despite the low number of participants, we can observe positive responses and the potentially positive impact on clinical practice of short-term training courses, the importance of which for experienced professionals is underestimated.

Conclusions

The live animal model seems to be an interesting tool in advanced training in minimally invasive partial nephrectomy for kidney cancer – specially for established clinician urologists.

Ethical statement

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Experiments were performed under a project license reference code: 001/20/Cert granted by *The Ethics Committee in Animal Experimentation of the "Jesús Usón" Minimally Invasive Surgery Center*, in compliance with existing laws for the use of experimental animals (Royal Decree 53/2013, of February 1st) for the care and use of animals.

Conflict of interest: none declared

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