SKILL AND TALENT

Animal model for training in laparoscopic pyeloplasty

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Abstract

Objectives: With the coming of the laparoscopy, multiple surgical techniques have been developed that have revolutionized the urological practice. Laparoscopic pyeloplasty has been one of the most developed techniques. However, there are few training models that permit the surgeon to decrease the learning curve. An animal model of training for the laparoscopic pyeloplasty technique is described.

Methods: Eight procedures of laparoscopic pyeloplasty were performed using the animal model (\textit{Gallus gallus}) in the laparoscopic practice laboratory of the Urology Service of the University Hospital of Caracas. The preparation times of the model and the operation times of each surgeon were compared. The statistical analysis was made calculating the mean operation time, standard deviation, frequencies and percentages. A significant value was considered as $p<0.05$.

Results: The laparoscopic pyeloplasty procedure was performed successfully in all of the cases by two surgeons. The preparation time ranged from a maximum of 14 min to a minimum of 6 min, this being the same for both surgeons in the fourth case. The operation time ranged from a maximum of 65 min to a minimum of 43 min, observing significant differences when comparing the times individually for each surgeon. Only one case had filtration when comparing the patency of the specimen.

Conclusions: The animal model of training of laparoscopic pyeloplasty that is described is economical, reproducible, of easy availability and it makes it possible to develop laparoscopic surgical skills and competency necessary for reconstructive surgery and techniques that warrant intracorporeal suture.

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Introduction

Since the 1980s, with the advent of laparoscopy, multiple surgical techniques that have somehow revolutionized the current urological practice have been developed. The extension of laparoscopy into new domains of urology has created the need to change the methodology of training. Whereas previously the practice of urologic laparoscopy was performed directly on the patient, today’s practitioners of these techniques must ensure appropriate development of laparoscopic skills before starting their practice on patients, and, thus, provide optimal surgical technique with minimal complications.1-3

Within the training process, some steps must be taken systematically and progressively, from inanimate models to live animal models. Initial practice on inanimate models improves eye-hand coordination; this should be followed by practice on animal models in wet laboratory, initially with dissection and ablative procedures such as nephrectomies, and gradually progressing to advanced techniques involving the laparoscopic suturing.1

The rapid advancement of laparoscopic surgery and its insertion in urological practice have led the research and development of new training models that will allow the urologist to develop skills and abilities in each of the levels of complexity of training, which provide the development of a greater number of surgical procedures, with a more refined surgical technique and with better results.4

All this leads to the creation of an economical, simple, and reproducible training model to develop learning skills and abilities in urological laparoscopic techniques, especially for laparoscopic pyeloplasty. Ablative procedures are generally performed in the porcine model, but there are no effective animal models for the development of skills in reconstructive surgery, especially in laparoscopic pyeloplasty, hence the interest in developing a new animal model (Gallus gallus), specifically a segment of the gastrointestinal tract (esophagus and crop), to simulate the steps followed during laparoscopic pyeloplasty and, thus, allow the urologist the possibility to develop the technique and practice their skills in laparoscopic suturing.

Materials and methods

Population and sample

We used 8 adult birds (G. gallus), which were freshly killed and plucked, and large in size. We performed the Anderson Hynes type laparoscopic dismembered pyeloplasty technique, using a black box for laparoscopic training. The animal surgery was performed according to the parameters established by the Guide for the Care and Use of Laboratory Animals.3 The selection of animals was carried out according to the size and characteristics of the tissues, following the bioethical standards for animal experimentation established by the Declaration of Helsinki.6

Model preparation

We proceeded to neck dissection, visualizing the structures of the same and separating the trachea from the esophagus...
and crop. Careful dissection was performed with emphasis on the connection between both structures. We proceeded to drain and rinse the content of the crop and esophagus. Both structures were filled with physiological solution using a 12 Fr Nelaton catheter (Fig. 1A).

Subsequently, the proximal esophagus was ligated with 0 silk suture right after removing the probe, making it possible to maintain the liquid in the cavity and, therefore, the proper form of the structures (Fig. 1B). The model was placed inside the black box in a transversal direction to the operator, making a proper fixing of the same to avoid its mobilization.

Surgical technique

Three ports are placed respecting the principles of triangulation: central port for the optics (10–12 mm) and left and right ports for the clamps (5 mm). The surgeon is perpendicular to the animal model, and the first assistant to the surgeon’s left. The instruments, optics, and laparoscopic clamps are introduced. The esophageal-crop junction is identified and dissected. A reference suture with Vicryl® 3-0 is placed in the crop near the esophageal-crop junction. We proceed to the section and tissue resection (esophageal-crop junction), which represents the ureteropelvic stenosis. Oblique section and spatulate of the esophagus is carried out. After anastomosis area orientation, we proceed to place reference points on the most distal end to the operator with Vicryl® 3-0-SH needle between the esophagus and crop (ureteropelvic junction) (Fig. 2A).

First, we perform raffia on the posterior side of the esophageal anastomosis with the crop with Vicryl® 3-0-SH needle continuous sutures, and then the anterior side. The remaining defect of the crop is finally closed, simulating the renal pelvis (Fig. 2B). We fill the esophagus and the crop through a Nelaton at the proximal end of the esophagus to verify impermeability of the suture (Fig. 3A). We proceed to the opening of the piece and the visual assessment of the anastomosis (Fig. 3B). Minor surgery equipment and basic instruments in laparoscopic surgery, a black box, and disposable laparoscopic material were used.

Statistical method

The statistical analysis of the data was performed using graphs and tables expressing the results of each procedure
in a descriptive way. We used the SPSS application for data analysis. We calculated the mean and standard deviation for continuous variables; in the case of nominal variables, we calculated their frequencies and percentages. The comparison of surgical and preparation times between each surgeon was based on the non-parametric Mann–Whitney’s U test, and in the case of contrasts, for each surgeon, we used Pearson’s Chi-square test. A significant value of contrast was considered if \( p < 0.05 \). The data were analyzed using JMP-SAS 9.

**Results**

A total of 8 chickens was included, 4 for each surgeon, representing, thus, 50% of the procedures and fairly evaluating each surgeon. We evaluated the model preparation time by each surgeon observing differences that persist until the third attempt, from which similar times can be observed. No statistically significant differences are evident when comparing the times of each individual surgeon, nor when comparing the times between them (Table 1). On the other hand, there is an evident reduction in preparation time of 50% or more between the first and the fourth procedure of each surgeon, with times ranging from 14 to 6 min for surgeon 1, and 12 to 6 min for surgeon 2, with a final time of 6 min as the overall preparation time (Table 1).

With regard to the operative time, it ranged from a maximum of 56 min to a minimum of 43 min for surgeon 1, and from a maximum of 65 min to a minimum of 48 min for surgeon 2, with differences ranging between 9 and 5 min when comparing the results between them. No statistically significant differences are shown between the surgical times when comparing the surgical outcomes between surgeons. But, contrary to this, there is a statistically significant difference when comparing the results between the first and the fourth procedure of each surgeon, reflecting the development of skills in the management of instruments and intracorporeal knotting technique needed to develop this technique of reconstructive surgery (Table 2).

Another parameter evaluated was the quality of the anastomosis represented by the impermeability of the same once the procedure was finished, with the introduction of fluid into the model. Filtration was proved only in one of the 8 cases performed (12.5% of the procedures), while in the remaining cases it showed an hermetic and impermeable anastomosis.

**Discussion**

The extension of laparoscopy has created the inevitable need to change the methodology of training. Whereas

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Description of preparation times between surgeons: \( Z = 0.735 \) \( (p = 0.486) \).

Comparison of times in surgeon 1: \( Z = 0.005 \) \( (p = 0.998) \).

Comparison of times in surgeon 2: \( Z = 0.012 \) \( (p = 0.980) \).

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Description of surgical times between surgeons: \( Z = 0.145 \) \( (p = 0.886) \).

Comparison of times in surgeon 1: \( Z = 0.015 \) \( (p = 0.950) \).

Comparison of times in surgeon 2: \( Z = 0.025 \) \( (p = 0.922) \).
previously the practice of urologic laparoscopy was performed directly on the patient, today’s practitioners of these techniques must ensure the appropriate development of laparoscopic skills before starting practice on patients, and, thus, provide an optimal surgical technique with a minimum of complications.\textsuperscript{1,3}

Laparoscopic pyeloplasty has advanced rapidly since its first description, made by Schuessler in 1993,\textsuperscript{7} and it could become the gold standard for the treatment of the ureteropelvic junction obstruction.\textsuperscript{6,9} Of all laparoscopic procedures, certainly, reconstructive procedures such as pyeloplasty are technically the most demanding, because they require intracorporeal suturing and involve a risk of complications during the learning curve.\textsuperscript{10-14} This reality has brought the need to design models to mimic the laparoscopic techniques in the training labs.\textsuperscript{4}

In this process, we must take certain steps systematically and progressively, from inanimate models to live animal models. Initial practice on inanimate models improves hand-eye coordination, which must be followed by wet laboratory animal models, initially with dissection and ablative procedures such as nephrectomies, gradually progressing to advanced techniques involving laparoscopic suturing.\textsuperscript{5}

Regular training and standardization of the suture technique can reduce operative time by up to 50% and knotting time up to 75%, improving the efficiency and safety of reconstructive surgery.\textsuperscript{15} This is evidenced by the reduction of the surgical time of this work by noticing statistically significant differences between individual times of each surgeon.

Training models can range from live animals to simulators and models created with synthetic material or animal tissue, such as the present model. The main limitations for the use of live animals are the ethical considerations and the cost.\textsuperscript{16} The simulators and synthetic models are also costly, which limits their availability. There is, therefore, a need for training models of low cost and easy availability.\textsuperscript{16,17} Numerous training models have been described for laparoscopic ureterovesical anastomosis,\textsuperscript{18-20} but not for laparoscopic pyeloplasty.\textsuperscript{21}

In residency training, the initial stage of practice in suturing can be carried out with inanimate models and simple tissue models, but this sequence becomes repetitive and boring for the training staff, in the absence of an aim to achieve. Therefore, the model described here provides an end or aim, to complete the ureteropelvic anastomosis, so it might be more useful when using anatomical structures similar to the ureteropelvic junction, providing a real tissue and anatomy sensation. This model also provides an important detail, the presence of tissue around work items, which simulates the surgical technique in a more real way. Finally, the postoperative evaluation of the model makes it possible to verify the specific moments of the technique that need improvement.

In summary, we present an animal model for laparoscopic pyeloplasty training that makes it possible to reproduce the conditions required to develop laparoscopic surgical skills and abilities, necessary to perform techniques that deserve intracorporeal suturing.

**Conflict of interest**

The authors declare that they have no conflict of interest.

**References**

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