

The ideal experimental training session for minimally invasive endoluminal techniques

Introduction

Advanced endoscopy training on Endoscopic Submucosal Dissection (ESD), Endoscopic Mucosal Resection (EMR), Peroral Endoscopic Myotomy (POEM) Endoscopic Zenker's diverticulotomy and Gastrostomy with gastropexy is needed to achieve safe practice in patients. It is important and advisable starting these procedures in a living model as a previous step to the application of these techniques in human cases.^{1,2}

The *in-vivo* pig model has proven to be adequate for endoscopic training in the upper digestive tract.^{3,4} Anatomy of the pig's stomach is quite similar to the human anatomy, even though it has a stronger and protruding Pylorus (Torus Pyloricus).⁵ Other important anatomic difference is that every pig has a faringoesophageal diverticulum, which is actually convenient for training of Zenker's diverticulotomy. Additionally, the pig is the most appropriate animal model for training POEM due to its human anatomic similarity. Pigs have a long esophagus, so are good models for practice to perform the tunnel, and have been widely used to study and train this technique.⁶⁻⁸

This *in-vivo* model can be used not only for gastric, but also for esophageal and colonic ESD and EMR training. One of the main limitations of the *in-vivo* porcine model is the need to clean the colon, which can be a difficult task.⁹ However in our experimental unit we have been able to standardize adequate colonic preparation with 1250 ml of mannitol solution 20% 24 hours before the training session. Any material which might be eaten by the pigs should be removed from the floor in the animal laboratory. An additional advantage of colonic preparation is that it diminishes the presence of residual ingested materials in the stomach as well, therefore improving quality of training on gastric procedures.

An important advantage of the *in-vivo* model, as compared to the *ex-vivo* is that the former is more realistic, with preserved peristalsis, intraluminal secretions, and with possibility of bleeding or perforation as potential complications. Treatment of complications becomes part of the endoscopic training. In our unit coag-grasper is used in case of bleeding, and hemo-clips are applied for treatment of microperforations. Moreover, this model offers the possibility to assess the post-treatment evolution of the animals in survival studies.

To our knowledge, the *in-vivo* pig model has not been proposed as a tool to achieve advanced training on multiple procedures during the same training session. Several studies have described the usefulness of the *in-vivo* pig model for specific procedures, mainly gastric, esophageal or colorectal ESD, POEM or Zenker's diverticulotomy.¹⁰⁻¹³ Additionally, short experimental courses mainly focus on developing skills to a specific technique in a particular organ of the animal. This may lead to a lower number of undertaken procedures in other organs, and probably could account for a suboptimal management of the cost of having available experimental animals.

The veterinarian support is key for achieving well conducted training with controlled sedation and adequate pain management for animals. The ethics committee of our institution has approved every performed study, following the standard principles for animal

Volume 2 Issue 6 - 2015

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Received: October 01, 2015 | **Published:** October 30, 2015

experimentation. The veterinarians are responsible for euthanasia of animals, and closely follow them for signs of complications in survival studies.

One of the major limitations in training of these advanced techniques is the lack of experimental centers with experienced endoscopists who can provide appropriate supervision. There are few training centers around the world in which an endoscopy fellow can be trained on these techniques.¹⁰ We offer our residents a weekly exposure to experimental training under strict supervision of an experienced endoscopist (P.S) and we believe that standardization of the ideal experimental training session is important in order to maximize the results of our efforts.

While it is clear that skills acquisition improves with experience, the minimum number of procedures to achieve competence has not clearly been defined.¹⁴ The process of skills acquisition has been described as a sequential process. Different sources of workload have been described during this process, and are captured in a workload assessment tool known as the National Aeronautics and Space Administration Task Load Index. This subjective assessment of workload has been tested in several domains, including medicine, and have recently been adapted and validated as an Endoscopy Task Load Index that can be easily applied to several endoscopic procedures.¹⁵ We have demonstrated its applicability for colorectal ESD training, concluding that mental and physical demand diminish at the end of the training period.¹⁶ This valuable tool could be further applied to other endoscopic procedures in order to provide a better definition of the transition point between the intermediate and the fully automated phases of expertise development.

Besides training on standard endoscopic techniques, the *in-vivo* pig model also offers the opportunity for advancing the frontiers of minimally invasive surgery, where no precise limit divides the surgical and the endoscopic fields, and rather fusion them for the future advancement of care for our patients. We have recently created an endoscopically assisted colostomy technique that may serve as a bridge for surgical treatment for patients with partially obstructive rectal cancer¹⁷ and an endoscopic rectopexy technique for treatment of prociencia as an alternative to laparoscopic surgery in patients that are not well fitted for surgery. Moreover we have not stopped at this

frontier and continue working in the development of new devices for pexies in the gastrointestinal tract that can facilitate gastric tubes placement in selected patients.

Conclusion

In summary, the porcine model is a very efficient training *in-vivo* system for advanced endoscopic procedures that allow us to reproduce and treat potential complications in a controlled and safe environment. Training on gastric and colorectal ESD, colorectal mucosectomy, POEM and Zenker diverticulotomy can be achieved during a single training session. Optimization of the training session provides an excellent opportunity for residents and trainees, maximizing the benefit of the cost of the animal and the opportunity of achieving supervised training by an experienced endoscopist. Moreover, development of new minimally invasive techniques and devices can be safely tested before application in humans as we continue to expand the endoscopy clinical frontiers.

Acknowledgments

None.

Conflicts of interest

The authors declare there is no conflict of interests.

Funding

None.

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