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ORIGINAL ARTICLE

Laparoscopic needle catheter jejunostomy placement: development and description of a laparoscopic jejunostomy placement procedure and simulator

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Abstract

Background: Many different techniques for laparoscopic jejunostomy placement have been described and there is currently no realistic simulation model for training. The aim of this article is to describe a simple laparoscopic needle jejunostomy placement procedure and to develop a realistic simulator. **Methods:** We developed a simple 10-step laparoscopic needle jejunostomy placement procedure and created a training model with special attention to a realistic experience throughout the procedure, consisting of intraperitoneal as well as external manipulation. **Results:** The procedure and the simulator were developed and tested by two experienced surgeons. The procedure could be reproduced by two novice medical students after minimal basic laparoscopic skills training. **Conclusions:** The laparoscopic jejunostomy placement procedure and simulator described here have the potential to become a realistic and achievable training model, but further validation is needed.

Keywords: *jejunostomy; professionalism; laparoscopy; high-fidelity simulation training*

Introduction

Patients with obstruction of the esophagus, gastro-esophageal junction or stomach may be palliated with a jejunostomy feeding catheter to achieve enteral feeding access and avoid (long-term) parenteral nutrition.[1,2] Most of these patients have a malignant obstruction, therefore a staging or interventional surgical procedure will be planned; a simple laparoscopic technique for jejunostomy placement could be added to that procedure in most patients.

Several techniques for laparoscopic jejunostomy placement have been described using different catheter types (with and without a balloon),[3,4] different catheter diameters,[3,5] different abdominal access routes (with or without mini-laparotomy),[6,7] different bowel access (with or without Witzel)[4,5,7] and different fixation techniques (endoscopic suturing or transfascial fixation).[3,4,8]

Our center embarked on the development of a laparoscopic needle catheter jejunostomy technique. Although it is considered to be a minor, simple surgical procedure, different laparoscopic skills must be mastered. Working at the abdominal wall (camera handling), tissue friendliness (handling techniques) and suturing (needle positioning) are important parts of the operation. Given that clinical indications are scarce, these procedures are not performed regularly in routine surgical practice, and therefore residents might be underexposed to this operation during training. It would be useful to offer a similar yet simple training tool to surgical residents in training. However, although effective for training, low-cost laparoscopic simulators are often limited to manipulations 'inside' (intraperitoneal) the simulator,[9,10] but in this specific procedure, manipulations 'outside' (skin and abdominal wall) are equally important.

The aim of this article is to describe a simple technique for laparoscopic needle jejunostomy catheter placement using a newly developed high-fidelity dry simulation model.

Methods

The team

The simulator was developed, fine-tuned and tested by a team of five people with different backgrounds: two

experienced surgeons (with expertise in esophageal surgery and feeding access surgery), one expert in simulation and laparoscopy training (without clinical experience) and two medical students (2nd year) without any experience in laparoscopy or simulation.

Procedural steps

The clinical procedure had already been widely performed and standardized in the Department of Thoracic Surgery of our hospital and consists of the following ten steps:

1. Insufflation of the peritoneal cavity with CO_2 (15 mmHg) and placement of three 5-mm ports under direct vision: one in the right flank, one in the right hypochondrium and one in the right iliac fossa.
2. Lowering the intraperitoneal pressure to 8–10 mmHg. Visual confirmation of the ligament of Treitz and localization of the enteral entry point 20 cm more distally. Visual confirmation of the possibility of getting the enteral entry point against the abdominal wall in the left flank.
3. Laparoscopic placement of the first stitch in the longitudinal direction into the bowel wall at the level of the enteral entry point and removing the needle.
4. After incising the skin at the level of the presumed exit of the catheter in the left upper quadrant, picking up one end of the thread with a suture passer through the skin and the entire abdominal wall. Same procedure for the other end of the thread through the same skin incision, but with a bridge of tissue at the level of the outer abdominal wall.
5. Repeat steps 3 and 4 with another suture placed parallel to the first one, both at the level of the bowel and at the level of the abdominal wall, again through the same skin incision.
6. Seldinger needle puncture via the skin incision through the abdominal wall between the sutures and into the bowel wall with creation of a 2-cm submucosal tunnel made by hydro-dissection before entering the intestinal lumen.
7. Placement of a 9.8 Fr jejunostomy catheter (Vygon, 8 rue de Paris 95440 Ecouen, France) with the Seldinger technique into the intestinal lumen.
8. Repeat steps 3 and 4 with another suture placed 2–3 cm more distally from the first fixation to the bowel and through a new skin incision, again 2–3 cm away from the first one, thus providing an anti-rotation anchoring point of the small bowel loop.
9. Knotting all sutures against the abdominal wall and checking the functionality of the catheter, attaching the catheter to the skin with a dressing to prevent luxation of the catheter.
10. Removal of the ports and skin closure.

Materials

The simulator was assembled with the Simsei laparoscopic trainer including a camera (Applied Medical, 22872 Avenida Empresa, Rancho Santa Margarita, CA 92688, USA) as the training box with the Simsei large abdominal wall insert (LTC09; Applied Medical) to mimic the abdominal wall (Fig. 1).

Other materials needed for one procedure are as follows: two laparoscopic fenestrated clamps, laparoscopic scissors, one laparoscopic needle holder, three 5-mm ports, three sutures with needle, a Simsei simulated anastomosis model (ref. LTT12; Applied Medical) to mimic the small bowel (partially mobilizing the two silicone layers to facilitate creation of a water tunnel), a scalpel, a sharp-pointed suture passer, a Seldinger jejunostomy kit (Vygon), two mosquito clamps, a 10-mL syringe and water (Fig. 2).

Supplementary Video 1 shows an overview of the important procedural steps both in real life and on the simulator.

Results

The two surgeons found the simulator model to be realistic, especially regarding simulation of the gestures at the level of the abdominal wall and the creation of the submucosal tunnel in the two-layered bowel model (Fig. 3). The students were exposed to laparoscopic skills and to the procedural steps on four separate occasions after which they were asked to perform the procedure on the simulator:

1. Introductory session and attending a real-life laparoscopic needle jejunostomy placement in the operating room with a staff surgeon (1 hour in total);
2. Learning the different steps of the specific procedure with the two surgeons (2 hours);
3. Acquiring laparoscopic basic skills with the training and simulation expert during in-depth laparoscopy training (3 hours);

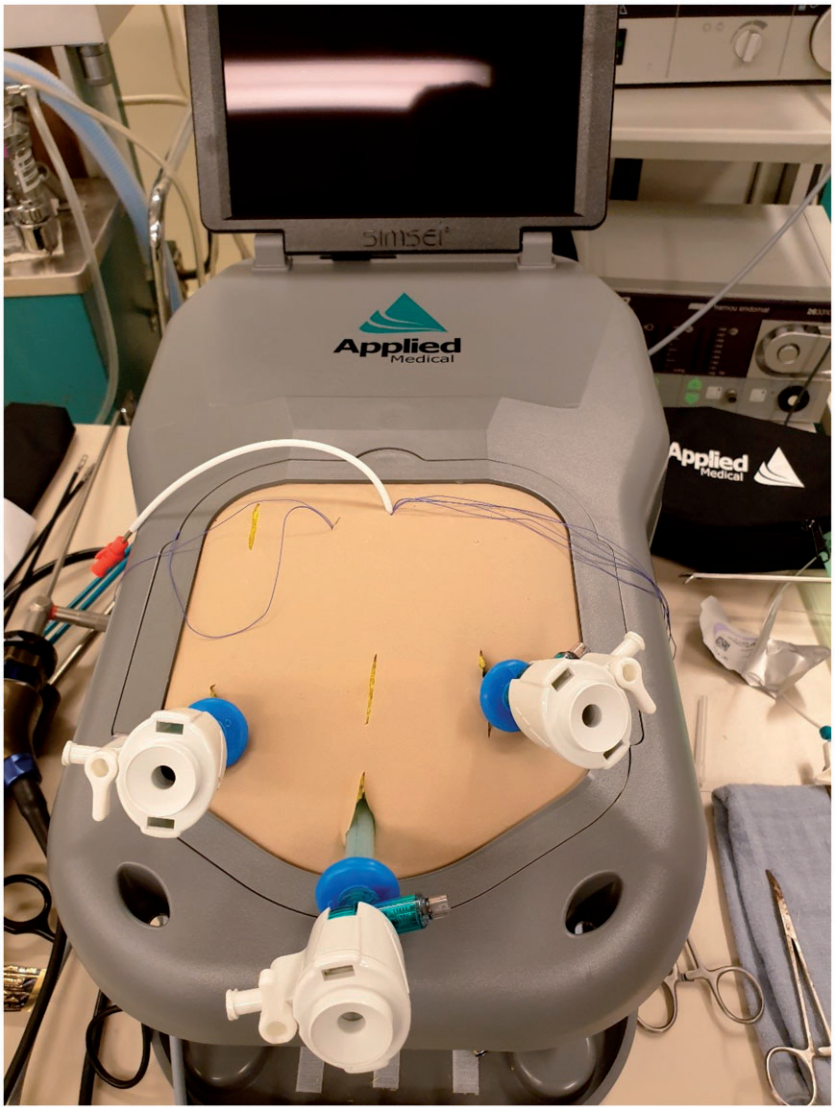

Figure 1. Laparoscopic training box (Simsei laparoscopic trainer and Simsei large abdominal wall insert, LTC09; Applied Medical) with three ports and jejunostomy catheter.

4. Training in basic laparoscopy skills without supervision (2 hours);
5. At the final encounter, both students succeeded in completing the laparoscopic jejunostomy placement procedure as described in 50 minutes.

Discussion

We designed a new laparoscopic needle jejunostomy placement procedure and simulator with the specific aim to create a simple and easy reproduceable procedure, combined with a realistic 'inside view' as well as a realistic 'outside view'.

Laparoscopic needle jejunostomy catheter placement is perceived as a relatively minor surgical procedure but with potentially high complication rates of up to $>50\%$.[11] In the authors' experience, the most frequently encountered complications using this technique are dislocation (28%), obstruction of the catheter (13%) and local wound problems (3%). The need for reoperation because of peritonitis or strangulation was $<1\%$ in our experience.

Many techniques have been described, which underlines the fact that a standardized technique has not been established yet.[3–8] The main advantage of the technique described here is the small diameter of the catheter, which can perfectly be placed percutaneously. The drawback of this percutaneous

Figure 2. Material needed for the procedure.

technique is possible perforation of the small bowel after the guidewire or the dilator enters the bowel lumen. We always flush the catheter with at least 60 mL of water to evaluate the bowel for accidental perforations. In the rare cases when this happens, a simple stitch on the perforation site is sufficient.

The technique described here has been performed on over 400 patients in our hospital and has been taught to many trainees, from first year rotating general surgery residents to senior fellows in upper gastrointestinal surgery. However, given the limited indications for the need for jejunostomy placement, the procedure is being performed less outside expert departments. Thus, exposure for residents depends on the occurrence of the procedure in the department where they are rotating.

Moreover, at present, surgery cannot be taught based solely on the Halstedian apprenticeship model, 'see one, do one, teach one'.[12] Therefore, the need for a simple and relatively cheap jejunostomy simulator is evident, but without the need for complex virtual reality simulators; both are equally effective.[10]

However, the practical issue with needle catheter jejunostomy simulation is that most simulators only consist of a training box with an 'inside view' (simulating the peritoneal cavity), whereas during needle catheter jejunostomy placement, actions outside the abdomen (simulating the acts performed at the level of the abdominal wall and the skin) are equally important.[9]

Therefore, our model was specifically created to simulate all important steps of the procedure as realistically as possible. The current setup with both the abdominal wall and the simulated small bowel, as well as all the steps of the jejunostomy placement procedure (from trocar placement, placing stitches in the bowel wall and through the abdominal wall to puncturing the bowel wall followed by placement of the feeding catheter using the Seldinger technique) were

Figure 3. End result of the simulated procedure.

perceived as realistic by the team. Both the setup and the stepwise procedure seem to have face validity.

The most important limitations of this simulator are the relatively short length of the bowel and the fact that the bowel has no mesentery in the simulator. This is less realistic and makes it even more difficult to place sutures than in a real-life situation because of the extra mobility of the bowel.

Furthermore, just as in every 'dry' model, the abdominal wall has no simulation of epigastric vessels, which could be injured by trocar placement, and there is no CO_2 insufflation, which could simulate the effect of pressure and counterpressure on the abdominal wall. On the other hand, the most important limitation in developing a simulator is the cost. This model seems to be a good compromise between face validity and cost.

By developing and testing this model in experienced surgical hands as well as transferring the procedural steps to novice surgical hands, we have shown that the model has the potential to become a realistic but also an achievable training model for laparoscopic jejunostomy placement.

The next step will be validation of the model by training, evaluating and comparing three different groups of users: medical students without any laparoscopic experience, surgical residents with basic laparoscopic skills and expert surgeons who are familiar with the real-life technique. After validation, the training model could be disseminated among trainees and fellows to provide training in the procedure on the simulator before performing this procedure in real patients.

Conflict of interest

All authors declare that they have no potential conflicts of interest regarding this article. The Center for Surgical Technologies KU Leuven is receiving equipment support from Applied Medical.

Supplementary material

Supplementary Video 1. Comparison between reality and simulator during the procedure. Available at https://youtube/1lsdE9l9nwI

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