Sim*Bowel

Training Guide

-Intestinal Suturing Skills-

Exercises for learning and practicing suturing skills required for enterotomy closure, oversewing bowel ends, end-to-end anastomosis, and side-to-side anastamosis

Suggested Exercises and Homework Assignments

Visit us on the web at

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Sim*Bowel

Sim*Vivo is proud to present our newest learning system, Sim*Bowel, which will provide an opportunity to practice hand-sewn bowel closure and anastomosis techniques. The purpose of this guideline book is to provide you with some suggested exercises that can facilitate your performance in the operating room when presented with actual patients. As with our other learning systems, Sim*Bowel contains all the materials and supplies to practice a variety of bowel procedures including:

- closure of an enterotomy
- oversewing bowel ends
- end-to-end hand-sewn anastomosis
- side-to-side hand-sewn anastomosis, and
- end-to-side hand-sewn anastomosis

This manual and the soon-to-be-available instructional videos will demonstrate a two-layer closure technique utilizing a running inner layer and an interrupted outer layer. While other bowel closure techniques are used by some practicing surgeons (i.e., a single layer closure or a two-layer closure with a running outer layer), the surgical literature supports equivalency. Often, the choice of closure lies in the preference of your mentor. For these exercises, we are going to demonstrate the most popular current techniques.

Included in this learning system are all the supplies required for the completion of these exercises and include:

- Learning board with two segments of attached bowel
- Hegar needle holder, DeBakey forceps, and Iris scissors
- Crile clamps (2) to provide traction to the end-sutures
- 20 pieces of black 3-0 silk on a 26 mm taper, ½ round needle, 75 cm length. This needle is equivalent to an Ethicon SH® needle.
- 20 pieces of white 3-0 silk on a 26 mm taper, ½ round needle, 75 cm length. This white silk has the characteristics of the commonly used polydioxanone (PDS®, Ethicon) but is much less expensive for simulation purposes.

At the outset, we should discuss some principles of bowel surgery.

1. ***Leaks are catastrophic!!*** A major goal of any bowel closure or anastamosis is to prevent any succus from crossing the repair into the surrounding tissue or cavity. The novice may think that the healing of the suture line is solely determined by the initial integrity of the repair. That is only partly true. Obviously, if a surgeon were to leave a large gap in the approximated bowel edges, a leak would certainly be predictable … usually, right away in the PACU. However, most leaks probably occur a few days after the procedure is completed suggesting that the healing process has been compromised. In most *cases this can be traced back to a limited number of factors:*
    a. *Poor blood supply at the wound edges*. Maybe the bowel mesentery was stripped away from the bowel ends leaving them ischemic. Or the blood supply to the

entire bowel was diminished through vascular occlusion. Or maybe, a tie was placed on a draining vein resulting in venous congestion. Adequate blood supply can usually be confirmed by bowel wall color, arterial bleeding at the edges, or fluorescein enhanced detection.

b. *Tension on the closure.* Once the bowel is placed back into anatomic position in the peritoneal cavity, a tendency for the edges of the closure to pull apart will work against the normal contractile characteristics of the healing tissue.
c. *Conditions for poor wound healing*. Bowel closures immersed in pus most likely won't be successful. Ostomy creation or proximal diversion will help avoid the consequences of leak. The surgeon can always "come back another day" after the abdominal purulence has cleared. The same goes for a repair or anastomosis in a previously radiated area. In this case, the microcirculation has been compromised leading to poor blood supply to the healing wound.

2. ***Strictures can be debilitating***. While the surgeon may take pride in the external appearance of an anastomosis, a narrowed lumen can lead to long term pain and discomfort which, in many cases, may require an additional procedure. With each repair or closure, the surgeon must take great care in guaranteeing adequate luminal dimensions. For these reasons, transverse rather than longitudinal closures are essential. "Catching the back wall" with an outer layer suture is an amateur mistake that can easily be avoided.

As noted, we will be practicing a two-layer procedure for closure and anastomosis. The inner layer is usually a running simple suture through all layers of bowel utilizing an absorbable material. The purpose of this layer is for hemostasis and the provision of a water-tight seal. The outer layer is primarily for strength with the sutures being placed through the sub-mucosa which is the sturdiest layer of the bowel wall. For the outer layer, suture entrance into the lumen should be avoided although there are few negative consequences if this were to occur. Once completed, the serosal surfaces of both sides of the closure should be approximated for healing.

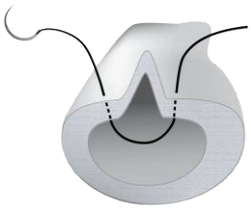

Figure 1: Suture goes through all layers on both sides

So, let's start with a simple closure of an enterotomy. With the scalpel and the Iris scissors, make a small one-inch incision on the exposed surface of one of the pieces of bowel about a quarter of the distance in from one end. You will see that the simulated bowel consists of an inner and outer layer representing mucosa and serosa. Between these two, is firm layer that can hold the sutures and corresponds to the submucosa. *Please note that, for clarity, all the figures for enterotomy closure show the repair to be in a longitudinal direction. To maintain luminal patency in the real circumstance, you would close the bowel transversely.* This closure will begin with an inner suture line that will encompass all layers of the bowel on both sides. Figure 1 shows a representation of this suture in cross-section, and you can see how it traverses the complete thickness on each side. This will be a running suture in order to gain hemostasis and make the closure water tight. To encompass the entire enterotomy, it is best to place the first suture slightly beyond the end of the enterotomy (Figure 2). Most surgeons would use an absorbable suture for this layer and prefer Vicryl® or PDS®. For training

Figure 2: Start at one end and tie a knot

purposes however, absorbable sutures are very expensive and their ability to dissolve rapidly is unnecessary, so we have substituted a length of 3-0 white silk for simulation purposes.

Start by loading your needle driver and then place the simple suture through both sides of the bowel. Tie this while leaving a tail that is about 4 or 5 inches long and tag it with a Crile clamp (George Crile … an icon of American surgery from Cleveland). This will allow your assistant to place traction on the suture-end while you are completing the closure. Continue placing simple running sutures approximately 3 mm apart (Figure 3) until you have reached the other end. Pull out a loop in the second to last cross stitch and use it to tie an instrument knot at the end. Again, leave a tail that can be clamped by the Crile which will provide traction to facilitate the placement of sutures in the next layer.

Figure 3: Running suture through all layers on both sides

For the outer closure layer, a Lembert suture technique will be used. This was proposed by a French surgeon, Antoine Lembert, in a publication concerning bowel anastomosis in 1826 but was not used on patients until 10 years later. This suture utilizes the strength of the submucosa on both sides and imbricates the inner layer closure by approximating folds of the serosa over the top. Figure 4 is a cross sectional diagram of this technique and shows individual bites on either side of the inner closure making sure that the submucosa is included but the lumen is not violated. Figure 5 demonstrates the approximation of the serosa that will protect the inner closure. This outer suture line will consist of interrupted sutures that begin just beyond one end of the inner layer closure (Figure 6). This is best accomplished by pulling the tail of the inner closure towards the enterotomy which will expose fresh serosa just beyond. This first suture is then tied and left with a long tail. The clamp is removed from the end of the inner layer closure (which is then cut) and placed on this first Lembert suture for lateral traction. In most cases, the next suture of the outer layer will be placed on the opposite side of the wound with the tail being clamped with another Crile. Now, your assistant can pull on the clamps attached to both tails which will elevate the bowel and provide traction to make placement of the Lembert sutures easier. The order in which the rest of the sutures are placed is up to you, but the final suture should be near

Figure 4: Outer layer suture through submucosa on each side

Figure 5: Upon tying, the serosa surfaces are approximated

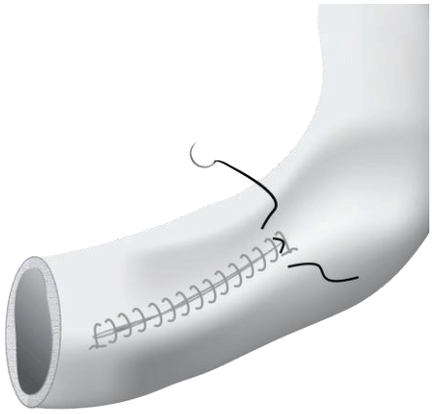

Figure 6: Start at one end with Lembert suture

Figure 7: Close from both ends and meet in the middle

the middle of the closure (Figure 7). To conserve suture, you should consider cutting each suture just after the knot has been tied. When completed, an evenly spaced row of knots should be seen on the surface of the bowel.

So, what do you think? Was the inner layer placed without too much "pooching" of the edges? Was it watertight? Were you able to imbricate the inner closure layer as the Lembert sutures were being placed.

Before moving on you should practice this a few more times. The best way to do this is by closing the open ends of the bowel with a two-layer closure that you have learned. Once you master these two-layer suture techniques, you will be able successfully complete even the most complicated of bowel anastomoses. Speaking of which, let's proceed on to a side-to-side bowel anastomosis.

The principles for a hand-sewn bowel anastomosis are the same as for enterotomy closure: two layers composed of an inner layer of running simple sutures and an outer layer of interrupted Lembert sutures. Once completed, you should have a tension free, hemostatic, water-tight, wide open connection between the two bowel lumens. In this model, the easiest anastomosis is side-by-side so let's start there. Approximate the serosal surfaces the middle section of the bowel segments to gain a reference of how they might go together. We will plan for an anastamotic opening of about 5 cm in length.

So here is the rub: for this anastamosis, you must place an outer layer of backwall sutures <u>before</u> the inner layer. Starting on the approximated serosal surfaces of the back wall, use the 3-0 black silk suture to place a Lembert suture which will approximate the serosal surfaces at one end of your proposed anastamosis. Leave a long tag which is secured with a Crile clamp. Now do the same thing at the other end and tag the tail with a clamp (Figure 8). While your assistant is pulling up the clamps to provide traction, place evenly spaced Lembert sutures to approximate the back wall completely. You should have between 7 and 9 sutures to provide a secure connection (Figure 9). Now you are ready to open the bowel with adjacent, parallel enterotomies. In the real operative situation, you would place non-crushing clamps on both sides of the proposed enterotomies to prevent leakage while closure is completed.

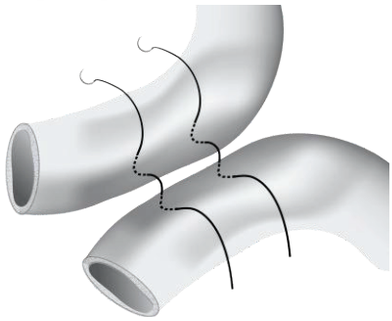

Figure 8: Outer layer Lembert sutures at each end of proposed anastamosis

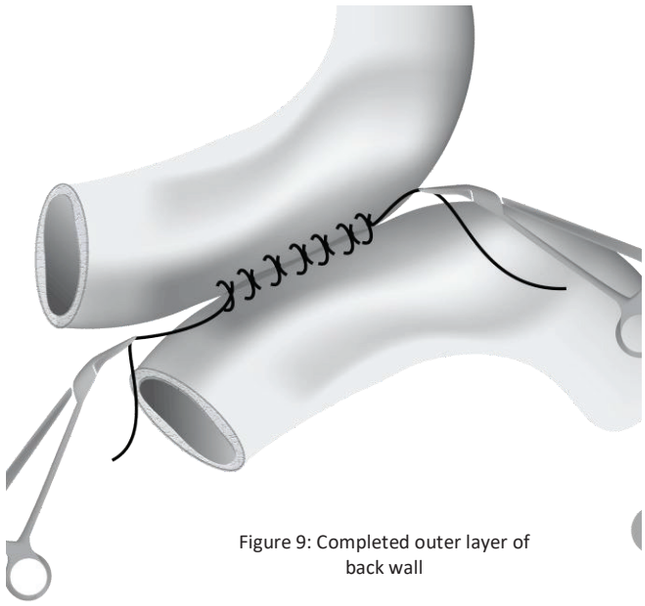

Figure 9: Completed outer layer of back wall

With the scalpel and scissors, make a longitudinal incision in each bowel segment adjacent to the back-wall closure. The inner

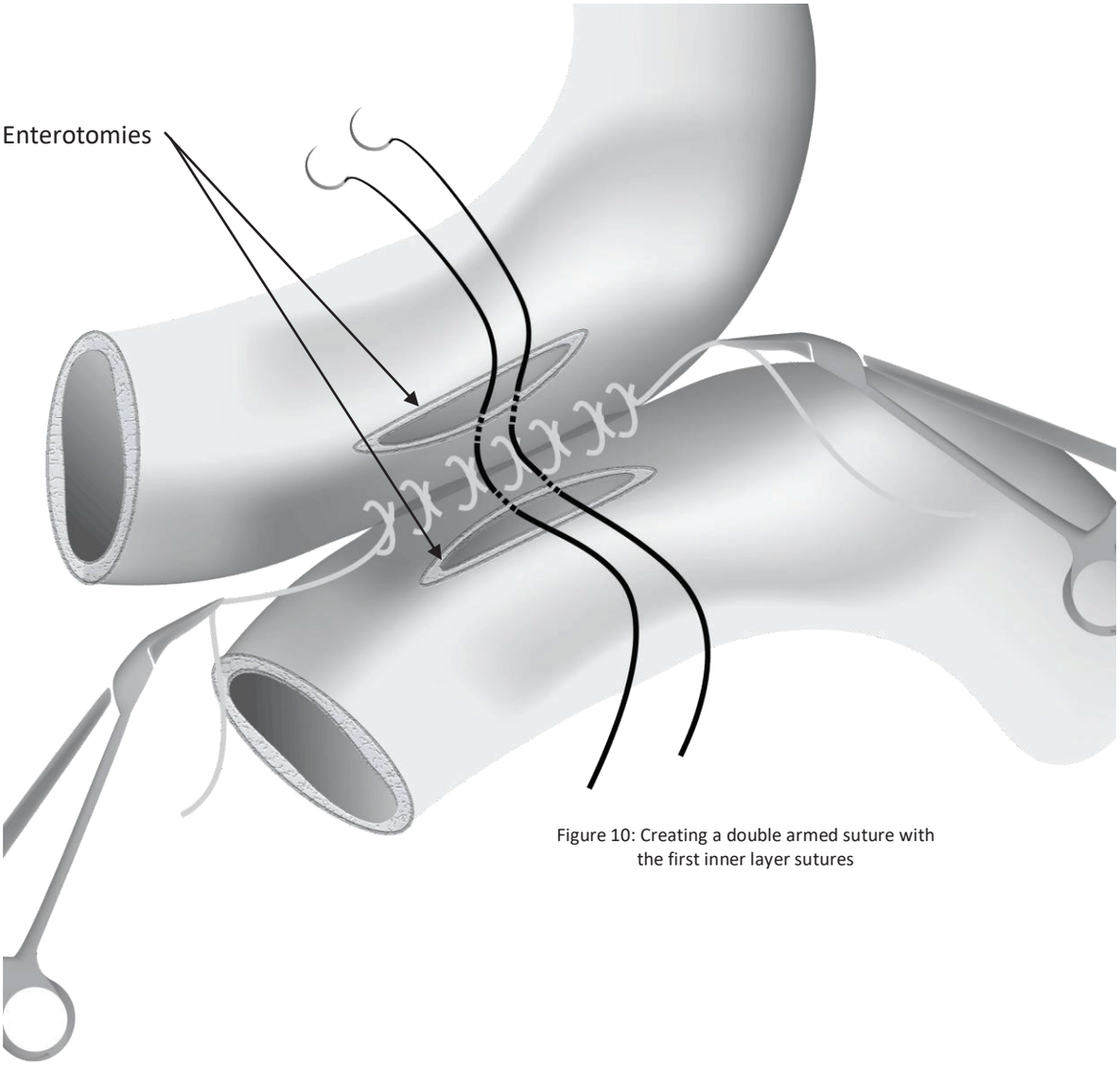

Figure 10: Creating a double armed suture with the first inner layer sutures

suture layer will be made easier if we can create a "double-armed suture" that can be run in both directions. Start by placing a simple suture through all layers of bowel on both sides using a 3-0 white silk suture. After tying this, place another suture next to the first and tie it (Figure 10). Next, tie the short tails of both of these sutures together. Voila …. you have created a double armed suture! It doesn't matter which direction you choose but begin running a simple suture toward the end of the enterotomy making sure that each bite includes all layers of both sides of bowel.

When you reach the "corner" (the spot where you transition the running suture from posterior wall to anterior wall), the technique changes to a Connell suture. To avoid "extrusion" of the mucosa, the goal here is to imbricate the edges of the wound by imbricating the serosal surfaces with the inner layer suture line. As shown in Figure11, the needle traverses the bowel from inside to outside and immediately is brought back to the lumen from outside to inside on the same bowel surface while advancing slightly. This pattern is continued on the other side until the needle is on the front side of the bowel after which the simple suture is resumed. Once the corner has been completed on one side, the suture line on the back wall using the other needle is continued going the other direction. Again, when the corner is

reached, the Connell technique is used until reaching the front wall. Simple running sutures are then placed from each end until the middle is closed and the knot is tied. The inner wall closure is made easier by continuing the traction with the Crile clamps on the lateral Lembert sutures.

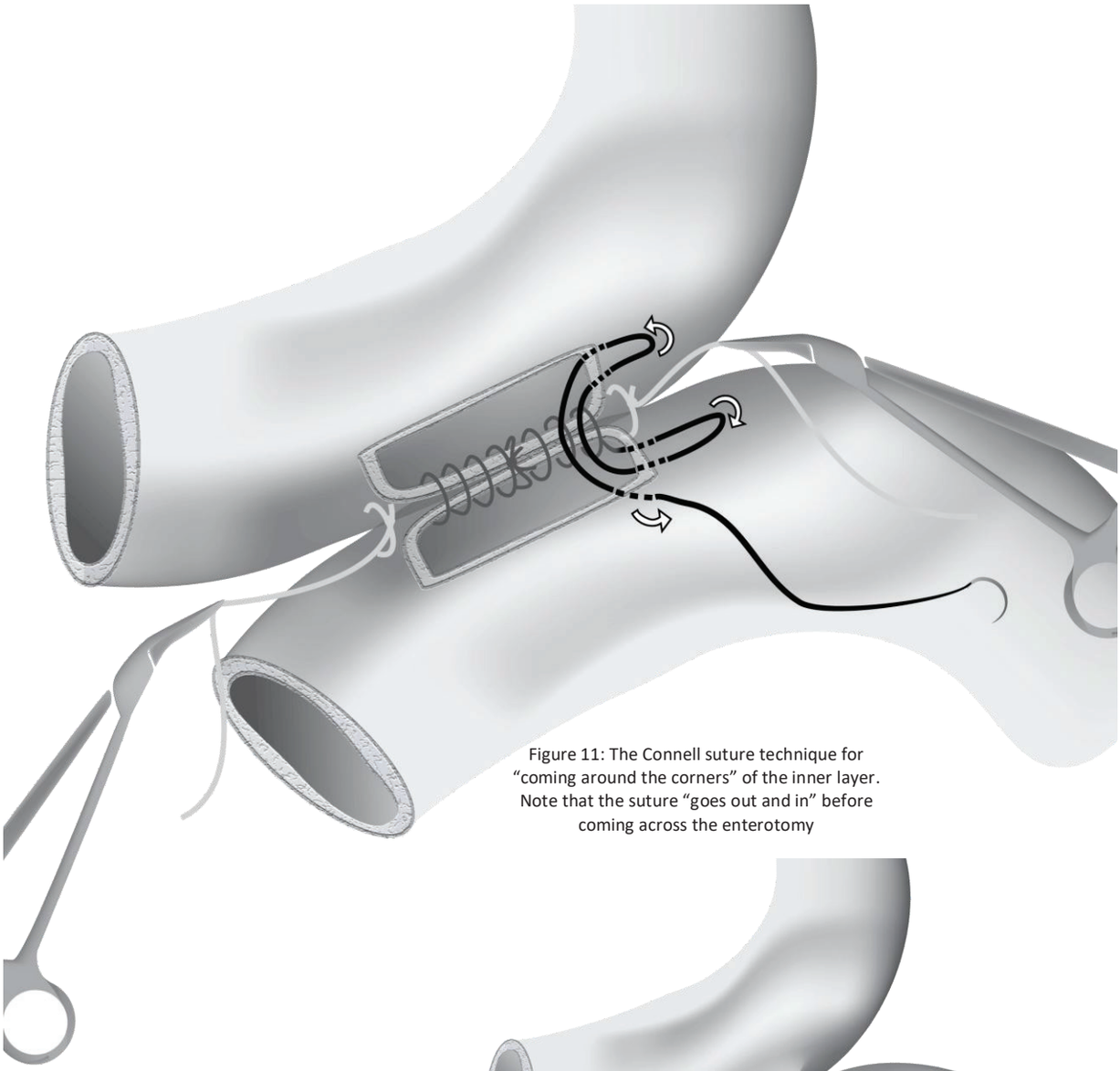

Figure 11: The Connell suture technique for "coming around the corners" of the inner layer. Note that the suture "goes out and in" before coming across the enterotomy

Once the inner layer is complete, the anterior outer wall is approximated with interrupted Lembert sutures of 3-0 black silk (Figure 12). After the last suture has been placed, inspect the anastomosis to look for exposed mucosa or obvious defects in the closure. Patency can be checked by

Figure 12: Outer layer of interrupted Lembert sutures completes the anastamosis

gently pinching the anastomosis and feeling for the "doughnut hole" which represents the intact lumen that you have maintained while creating this connection. How did you feel you did? Be honest!!

The practice options from here are only limited by the amount of suture that you have left. We have given you 20 long strands of both types of suture material so you should have plenty of materials to continue practicing these techniques. Try to close another enterotomy that you have created or cut a bowel segment into two pieces and perform an end-to-end anastomosis. The more you practice here, the better you will be in the OR.

We welcome any comments that you might have about this module. Please let us know about your experience by dropping us an e-mail at john@sim-vivo.com. From all of us at Sim*Vivo, we wish you the best of luck in your surgical career.

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Sim*Vivo learning systems are available for viewing and purchase on our website:

Sim*Suture – an inexpensive, complete module to learn simple interrupted and running sutures for skin closure. Contains suture board, instruments, suture, and guidebook. Free training videos available on our web site.
Sim*Tie – a knot tying learning system that provides all of the supplies to learn two- and one handed surgical knots including practice with difficult access and delicate structures.
Sim*Dissect – a practice module for the mastery of two-handed dissection techniques
Sim*Cath – an inexpensive complete central venous catheter kit to facilitate the placement of central lines in all available manikins.

Sim*Supply - a single source supplier of surgical simulation materials
Sutures – 3-0, 4-0 nylon; 2-0, 3-0 silk; #1 nylon; 5-0, 6-0 double armed vascular suture
Ties – 3-0 silk, 0 nylon, 6-0 nylon
Sim*Bandage – 4x4's, ABD pads, kerlix gauze roll for bandaging practice
Surgical instruments – Hegar needle driver; Adson, DeBakey, and Gerald forceps; Castroviejo vascular needle driver; Metzenbaum, suture, and iris scissors
Sim*Pad – a realistic suturing board with integrated guidelines to assist in novice education and practice.
Supplemental learning kits – supplies for Sim*Suture and Sim*Tie without the boards