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Technique of Laparoscopic Nissen Fundoplication

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This Nissen fundoplication technique has been successfully employed in more than 350 patients. It was designed with the knowledge that there are many technical variations in a laparoscopic Nissen fundoplication. The following specifics, however, were designed to provide maximum exposure and technical ease for the surgeon. It must be emphasized that this procedure can be done equally well whether the surgeon is right handed or left handed. This surgery however, can only be initiated if the surgeon is facile with the simultaneous use of both hands.

Room and Patient Setup

After general anesthesia is induced, the patient is placed in the modified lithotomy position with Allen stirrups and pneumatic compression boots are applied. Positioning is similar to that of a low anterior resection. An 18-gauge nasogastric tube and a 16-gauge bladder catheter are inserted.

As in all laparoscopic procedures optical correctness must be established. *Optical correctness* is defined as proper alignment of all of the visualization equipment such that there is no “operative site/video monitor directional discrepancy.” Optical correctness is established by having the surgeon, camera, operative site, and a monitor in a direct line (Fig. 9.1). In addition, surgeon must never operate with the monitor over his/her shoulder. Nothing is more frustrating or potentially harmful as moving the tip of an instrument to the right and seeing it move to the left on the monitor. This provides maximum flexibility and exposure during the procedure; furthermore, it means that surgeons will never be looking over their shoulder.

Trocar Placement

Table 9.1 and Figure 9.2 demonstrate the specific placement of each trocar. The first four are 10-mm trocars, but ports #5 and #6 are 5-mm trocars. With new instrumentation as well as advance miniaturized optics and hand

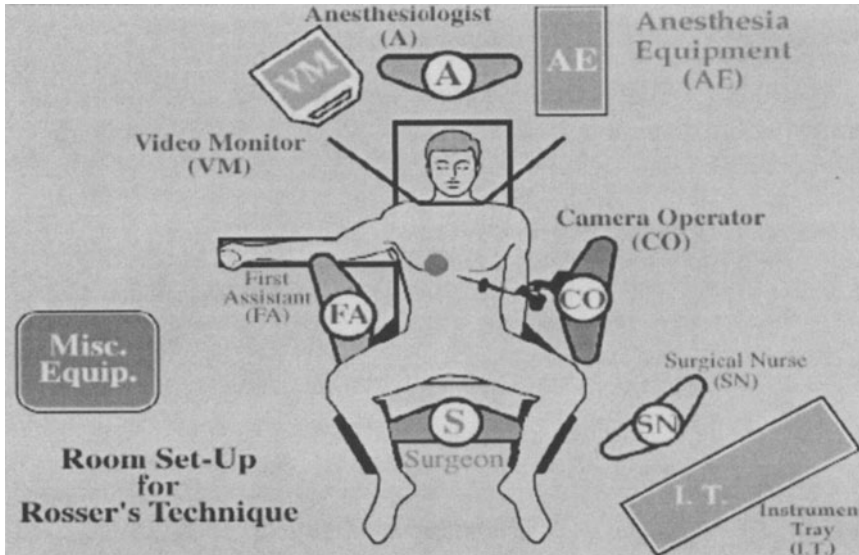


FIGURE 9.1. Schematic illustration of optical correctness in a laparoscopic Nissen fundoplication. In all laparoscopic procedures when the surgeon moves to the right, the image should move to the right on the television monitor; similarly, when the surgeon moves to the left, the image on the television screen should move to the left. Specific placement of all the operating room personnel and equipment. This facilitates optical correctness. Note that only one video screen is necessary in this orientation.

instruments, nearly all of these ports can be 5-mm trocars. Prior to all incisions, 2 ml of 0.5% bupivacaine is injected subcutaneously at the trocar site. A #11 blade is utilized for the incisions. Each incision must be at least the size of the diameter of the trocar to avoid an uncontrolled entry into the abdominal cavity.

After the camera is placed through trocar #1, the 30-degree laparoscope is rotated in an upward direction so that the anterior abdominal wall can be easily visualized.

We emphasize that all of the trocars should be placed through the abdominal wall in a perpendicular fashion. This facilitates ease of entry and avoids “bunching” of the trocars intraabdominally.

Pneumoperitoneum

A 10-mm transverse incision is made in the right upper quadrant, two fingerbreaths medial to the anterior axillary line and two fingerbreaths from the costal margin. The superior and inferior edges of the skin and subcuta-

neous tissue are lifted upward (e.g., with a towel clip), and an extra long Veress needle (150mm) is inserted. The long needle prevents dislodgment when lifting up on the skin.

After the Veress needle is placed, a 10-ml syringe is used to aspirate to check for blood or bile. Next, the drop test is performed. Three milliliters of saline are injected into the hub of the Veress needle. If the saline flows in easily, then the tip of the needle is usually in a proper location. It should be remembered that you obtain a false positive “drop test” if the needle is in the subcutaneous tissues.

After a positive drop test, the insufflation tubing is connected to the needle. The pressure should be 6mmHg or less; however, if the “critical opening pressure” is ≥ 10 mmHg, then the needle should be repositioned and the abdominal wall lifted up, and the drop test repeated. If the pressure is still high, and you feel comfortable with the needle position, then it may be necessary to use 25 mmHg for the first 1 L of insufflation (this is because it is not rare for a piece of omentum to impede flow of CO₂ in the right upper quadrant). After 1 L of CO₂ has been introduced, all four quadrants should be percussed to ascertain that an symmetrical and diffuse “global pneumoperitoneum” is present. A second test to ascertain a global pneumoperitoneum is to place direct pressure in the left lower quadrant

TABLE 9.1. Optimal placement of trocars.

Trocar#	Location of trocar	Purpose of trocar
1.	Two fingerbreadths below the costal margin & two fingerbreadths medial to the right anterior axillary line.	Initially for the veress needle & camera. After all trocars are placed, the liver retractor is inserted.
2.	Two fingerbreadths below the costal margin & two fingerbreadths medial to the left anterior axillary line	After all trocars are placed, the camera is inserted.
3.	Below the xiphoid process	Suction, irrigation, retraction, ultrasound coagulation.
4.	Two finger breadths below and two finger breadths lateral to trocar #2.	Retraction of stomach
5.	1/2 the distance between the xiphoid process and the umbilicus immediately to the right of the rectus abdominus muscle	Dissection & retraction. 5 mm ultrasound coagulation.
6.	1/2 the distance between the xiphoid process and the umbilicus immediately to the left of the rectus abdominus muscle	Dissection & retraction.

Note: Six trocars are usually utilized. They appear here as they are placed sequentially, 1–6. The right-hand column lists the surgical use of each of these trocars.

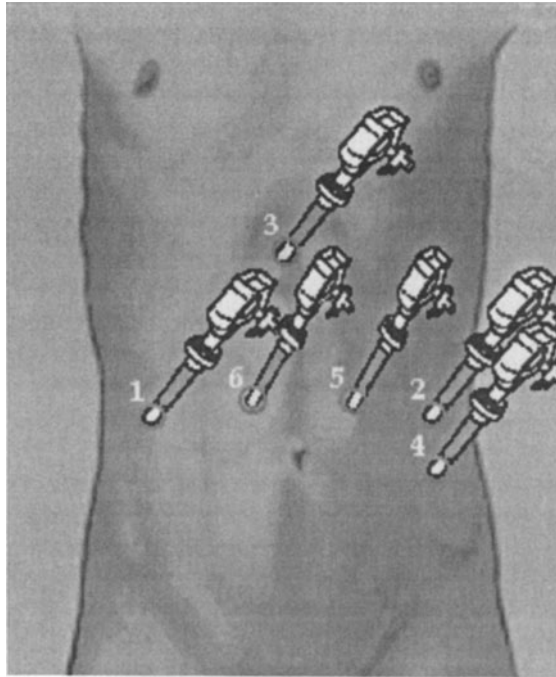


FIGURE 9.2. Schematic diagram of markings on the abdomen of all six ports after all six trocars are placed. Trocars #1–4 are 10-mm ports; trocars #5 and 6 are 5-mm ports (see text and Table 3.1).

and ascertain that the intraabdominal pressure reading increases by at least 5 mmHg. If the patient has any scar in the right upper quadrant (e.g. from a previous cholecystectomy), then an alternative site is chosen in the left upper quadrant. If this is not acceptable, then the pneumoperitoneum is established by the Hasson or Rosser technique.¹ The usual pressure of the working pneumoperitoneum is 15 mmHg.

After a pneumoperitoneum is established, the Veress needle is removed and a 10mm port is placed. This allows the insertion of a 30-degree laparoscope. It is rotated upward to provide visualization of the anterior abdominal wall. The #2 port site is a mirror image of the first, but it is placed in the left upper quadrant. This is the port used for the camera. Port #4 may not be necessary in some patients when the greater omentum is not massive and exposure can easily be obtained. The #5 and #6 trocars are placed immediately lateral to the rectus abdominus muscles while avoiding the superior epigastric vessels, usually halfway between the xyphoid and umbilicus. If the patient is particularly tall or large, then it may be necessary to place trocars #5 and #6 several centimeters more cephalad. After all six trocars are placed the camera is switched to the left upper quadrant port

(e.g., port #2). Figure 9.5 is a photograph of the abdominal wall of a patient after all six trocars were placed.

After all of the trocars are secured, the camera is moved to port #2 and the patient is placed in at least a 30-degree reverse Trendelenburg. The 30-degree laparoscope is rotated in a downward direction to view the operative field (Fig. 9.3).

Anterior Retraction of the Liver

The liver retractor is placed in the #1 port in the right upper quadrant. It is important to place the retractor under the left lobe of the liver when it is fully closed. The retractor is then deployed to an open position. The assistant retracts the liver with the right hand. The left hand is utilized for irrigation and suction through the #3 port (subxiphoid).

Inferior Retraction of the Stomach

The deployment of the retractor does not by itself establish proper exposure. The stomach usually must be retracted in a inferior and lateral direction. This is accomplished by placement of a Babcock retractor through port #4. This completes the exposure of the gastroesophageal region.



FIGURE 9.3. Photograph of appearance of abdominal wall in patient undergoing laparoscopic Nissen fundoplication after all six ports were placed.

The goal in steps 5–7 is to expose the distal esophagus. Approximately 90% of this dissection should be done without cautery. This helps in decreasing the chance of esophageal injuries; however, cautery should be used without hesitation in the appropriate situations. The control for the coagulation is usually by a foot pedal. Because hemostasis is so critical in this procedure and to avoid inappropriate use of the cutting current, the cut setting should be set to zero.

Maturation of the Horseshoe Dissection Pattern to Expose the Lower Esophagus and the Esophageal Hiatus

A layered approach must be emphasized because it promotes the orderly and safe progression of the dissection phase of the procedure. Immediately identify the gastrohepatic ligament, the phrenoesophageal ligament, and the gastrosplenic ligament. The surgeon must first be aware of two anatomical structures in harm's way: the caudate lobe of the liver and an aberrant hepatic artery.

Division of the Gastrohepatic Ligament

This step initiates a horseshoe (∩) dissection configuration that begins on the right side of the esophagus and ends on the left side. The gastrohepatic ligament is retracted to the patient's left by using a grasper through the #5 port. The caudate lobe of the liver can usually be seen through this somewhat transparent structure. Endoshears are used through port #6 to cut the mostly avascular gastrohepatic ligament.

Twelve percent of patients will have an aberrant left hepatic artery, which comes in various sizes. It is found in the cephalad portion of the gastrohepatic ligament. This aberrant vessel should be spared. If it is less than 3 or 4 mm in diameter, however, then it can be sacrificed without fear of complications.

Dissection of the Superficial and Deep Phrenoesophageal Attachments

This area represents the closed portion of the horseshoe dissection pattern. The dissection initially takes down the peritoneum only with Endoshears through the #6 port. Then, the deeper dissection is accomplished with a blunt technique utilizing a peanut through the #5 port. Some cautery may be necessary in this area, which is usually vascular (secondary to the esophageal branches of the left gastric artery). Great caution must be used, however, because the underlying esophagus is prone to thermal injury.

Dissection of the Superficial Gastrophrenic Attachments

Mostly blunt dissection is utilized to divide the gastrophrenic attachments, which start in the area anterior and to the left of esophagus. A grasper is placed through port #5 and a peanut and/or Endoshears are used through port #6. Cautery is not used in this part of the dissection, but it can be used when necessary. Be careful not to extend your dissection into the gastro-splenic ligament. You may be met with uncontrolled bleeding from the short gastric vessels.

Separation of the Esophagus from the Right and Left Crus

Initial separation of the esophagus and the right crus is obtained with a grasper through the #6 port and a Maryland dissector through the #5 port. The Maryland is spread parallel to the fibers of the right crus along a white line denoting the anatomic separation point of the two structures. After initial separation, two blunt dissectors (peanuts) are inserted into the #5 and #6 ports. They are simultaneously thrust in opposite directions (cephalad and caudad). This maneuver completes the separation.

Maturation of the Retroesophageal Window

Only blunt dissection is used to complete the retroesophageal dissection. This is necessary to decrease the possibility of esophageal or gastric perforation. The dissection is continued by using the "SWIM TECHNIQUE." The right-hand instrument is used to elevate the esophagus, whereas the left hand bluntly dissects. As the esophagus is liberated the right hand is progressively repositioned with an instrument over instrument motion until the retroesophageal window is completed. In order to further mature the retroesophageal window, blunt dissection is continued with the two peanuts in a cephalad to caudal direction. This is known as "walking the dog." If there is any difficulty in breaking through the gastrophrenic ligament and completing the maturation of the retroesophageal window, then proceed directly to division of the short gastric vessels. Ligation and division of the short gastrics facilitates the retroesophageal dissection.

It is important to avoid excessive dissection into the mediastinum to prevent pleural entry, and to avoid a pneumomediastinum or pneumothorax. Another potential hazard are vessels emanating from the left crus. Hook cautery may be necessary to coagulate these vessels. If they are large vessels, then clips should be utilized. Finally, limit posterior dissection because of the aorta.

Ligation of the Short Gastric Vessels

It is almost always necessary to ligate the short gastric vessels to assure adequate mobilization of the fundus. In order to accomplish this, the gastrosplenic peritoneum (e.g., the superficial peritoneum from the left curs of the diaphragm to the splenic capsule) must be divided. The vessels can be ligated with clips, bipolar, stapling device, or an ultrasonic coagulation and division device. This device moves $\geq 55,000$ cycles per second, which coagulates proteins and ligates the vessels. It is emphasized that this ultrasonically activated instrument can either be placed through a 5-mm United States Surgical Corporation (USSC) port or a 10-mm (Ethicon) port. If the 10mm instrument is used, then the #3 port will be used as the working site. The #5 port is used if the 5-mm instrument is used. The advantages include (1) minimal risk to adjacent tissue thereby negating the risk of propagation of a monopolar coagulation and (2) elimination of the suturing obstacles that clips present.

Specific technical details of take down of the short gastrics are as follows:

- i. The Babcock through the #4 port is repositioned and removes the greater omentum from the operative area.
- ii. A 5-mm grasper is placed through the #6 port to retract the fundus to the patient's right and place the gastrosplenic ligament under stretch.
- iii. A Maryland dissector is placed through the #5 port in order to create the initial entry into the lesser sac.
- iv. Use the Maryland dissector to spread parallel to the short gastrics, prior to ligation and division. Parallel dissection to the short gastrics is essential in order to avoid inadvertent shearing and subsequent bleeding of these blood vessels.
- v. Place a peanut or blunted grasper through the #3 port to retract the spleen in a lateral direction, if the 5-mm harmonic device is to be used. Place it through the #5 port, if the 10-mm device is used.
- vi. Use the #3 port to bring in the 10-mm harmonic device to coagulate and divide the short gastric vessels. If a 5-mm ultrasonic coagulation and division device (USSC Norwalk, Connecticut, USA) is used, then it is brought through the #5 port. Place a grasper through the #3 port to retract the cardia of the stomach in a medial direction and place the 5-mm ultrasonic coagulation and division device through the #5 port.

Placement of the Bougie Prior to Closure of the Hiatal Hernia

If the esophageal hiatus is greater than two times the width of the esophagus, then at least one suture is used to close it. A 0-nonabsorbable is recommended. Before suturing, a #50 French lubricated Bougie is passed

into the proximal stomach. It may be necessary to remove the nasogastric tube in order to facilitate passage of the Bougie. It is emphasized that in order to prevent perforation, a skilled and experienced anesthesiologist or surgeon must perform this potentially dangerous maneuver. After the Bougie reaches the level of the cricopharyngeus muscle, final placement is accomplished with visualization. Passage of the Bougie is facilitated by straightening the distal esophagus with gentle traction on the esophagus utilizing graspers through ports #5 and #6.

Closure of the Hiatal Hernia

An extracoporal suture technique is used to close the hiatus. The crura are approximated to each other with 0 nonabsorbable sutures. A Surgiwhip (122-cm extracoporal suturing appliance from USSC, Norwalk, Connecticut, USA) is used to facilitate this. Intracoporal suturing is not used because of the need to tie the knot under great tension.

A Rosser needle assist device (Cabot) grasps the nonabsorbable 122-cm whip stitch® (USSC Norwalk, Connecticut, USA) and places it through the #3 port. A Rosser needle holder (Cabot) is placed with the right hand through the #5 port and grasps the needle.³ The suture is placed either anteriorly or posteriorly to the esophagus depending on the natural anatomical configuration of the hiatus. The needle is passed through the left and right crus of the diaphragm with a “two-step” technique. In order to avoid trauma by pulling the suture through the tissue, the “pulley technique” is employed. The left-hand needle assist instrument is placed through the #3 port and picks up the suture 5 cm above the needle. The right hand guides the Rosser needle holder through the #5 port and pulls down the suture connected to the appliance. As the right hand pulls down the suture the left hand withdraws the needle until it exits from the number three port. When 15 cm of suture has been acquired, a fisherman’s knot is then executed. Break off the proximal end of the Surgiwhip® and the knot is pushed down to the operative site with the plastic portion of the appliance. Place the needle holder and assist device through the #5 and #6 ports. Gently tug on the two cut ends of the suture to further secure the knot. This is known as the “Cahow tug.”

Positioning of the Fundus Around the Esophagus

- i. The Bougie is removed and a blunt instrument is placed through the #5 and #6 ports to reestablish the retroesophageal space with the “swim technique”.
- ii. An aggressive grasper is placed through the #6 port and passed through the retroesophageal window.

- iii. The Babcock retractor is placed through the #4 port and used to position the stomach so that the cardiac portion can be passed to the aggressive grasper.
- iv. The stomach is then pulled through the window with the #6 port instrument and pushed with the #4 instrument. The Babcock is then used to grasp the posterior fundic portion of the wrap.
- v. Be careful not to twist the wrap. Make sure that the fundic wrap is floppy by bringing both portions of the wrap together. This is called the “Cahow Kiss.” This helps to document adequate looseness and mobility of the wrap.

Fundoplication

The length of the fundoplication should be 23 cm. An increased length of the wrap will increase the incidence of postoperative dysphagia. A 50–60F Bougie must be in place in the esophagus before the extracorporeal sutures are placed. The lower aspect of the fundoplication is established first. This helps to avoid constructing a “slipped Nissen.” This is accomplished by the extracorporeal technique described earlier. The esophagus is included in the suturing process. Two of these sutures are placed about 2 cm apart. Visualize the anterior vagus nerves and be certain that the needle does not pass through them.

Transabdominal Fixation Suture

After the Bougie is removed, a suture is placed between the posterior fundic wrap and the central tendon of the diaphragm. This suture is placed in order to maintain the wrap in the abdominal cavity. As previously described a single 0 nonabsorbable suture utilizing a Surgiwhip® (USSC Norwalk, Connecticut, USA) is placed.

Closure

Irrigation and inspection are meticulously accomplished. The fascia of all four 10-mm ports are closed with a 0 absorbable suture. The skin is approximated with 5-0 absorbable suture in interrupted subcuticular fashion, and steristrips are placed. The nasogastric tube and bladder catheter are removed while the patient is anesthetized.

Postoperative Care

On average, sips of liquids are initiated on the first postoperative day. A programmable analgesic intravenous distributor is utilized the first 24 hours. The diet is advanced rapidly to a soft diet and the patient is usually discharged home on the second or third postoperative day. We often do not admit the patient to the hospital; rather, the patient is admitted to an adjacent special postoperative recovery facility. This is known as the "Recovery Hotel."⁴

References

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