



## Anterior gastropexy may reduce the recurrence rate after laparoscopic paraesophageal hernia repair

J. Ponsky, M. Rosen, A. Fanning, J. Malm

Department of General Surgery, Minimally Invasive Surgery Center, Cleveland Clinic Foundation Desk, 9500 Euclid Avenue, A-80, Cleveland, OH 44195, USA

Received: 26 September 2002/Accepted: 5 November 2002/Online publication: 28 March 2003

### Abstract

**Background:** Although laparoscopic repair of type 3 paraesophageal hernias is safe and results in symptomatic relief, recent data have questioned the anatomic integrity of the laparoscopic approach. The reports document an asymptomatic recurrence rate as high as 42% with radiologic follow-up evaluation for type 3 paraesophageal hernias repaired laparoscopically. This disturbingly high recurrence rate has prompted the addition of an anterior gastropexy to our standard laparoscopic paraesophageal hernia repair.

**Methods:** A prospective series of 28 patients underwent laparoscopic repair of large type 3 hiatal hernias between July 2000 and January 2002 at the Cleveland Clinic Foundation by one surgeon. All the patients underwent reduction of the hernia, sac excision, crural repair, antireflux procedure, and anterior gastropexy. They all had a video esophagram 24 h after surgery, then at 3-, 6-, and 12-month follow-up visits and annually thereafter. Symptomatic outcomes were assessed with a standard questionnaire at each follow-up visit.

**Results:** In this study, 21 women and 7 men with a mean age of 67 years (range, 35–82 years) underwent successful laparoscopic paraesophageal hernia repair. The mean operative time was 146 min (range, 101–186 min), and the average blood loss was 71 ml (range, 10–200 ml). One intraoperative complication occurred: A small esophageal mucosal tear occurred during esophageal dissection and was repaired laparoscopically. At 24 h, upper gastrointestinal examination identified no leaks. At this writing, all the patients have undergone video esophagram at a 3-month follow-up visit. All were asymptomatic and all examinations were normal. Of the 28 patients, 27 have undergone follow-up assessment at 6 months. At this writing, all the patients have undergone video esophagram at 3, 6, and 12 months follow up visits. All were asymptomatic and all examinations were

normal. Ten patients have completed 2 year follow up barium swallows with no recurrences.

**Conclusions:** With up to 2 years of follow-up evaluation, the addition of an anterior gastropexy to the laparoscopic repair of type 3 hiatal hernias resulted in no recurrences. These encouraging results necessitate further follow-up evaluation to document the long-term effects of anterior gastropexy in reducing postoperative recurrence after laparoscopic repair of paraesophageal hernias.

**Key words:** Laparoscopy — Paraesophageal hernia repair — Recurrence — Anterior gastropexy

Paraesophageal hernias represent 5% to 10% of all hiatal hernias. On the basis of the relation between the stomach, the gastroesophageal junction, and the hiatal defect, these hernias are classified into four types [2]. Type 1 hernias are sliding hernias in which only the gastroesophageal junction moves cephalad and may predispose to gastroesophageal reflux. Type 2 hernias are anatomically characterized as pure paraesophageal hernias. The esophagogastric junction is in a normal anatomic position below the diaphragm, and the fundus herniates alongside the esophagus through an anterior weakness of the gastrophrenic ligament. These true paraesophageal defects are rare. Type 3 defects are a combination of both a sliding and a paraesophageal defect. Type 3 hernias tend to be large, and repair has been advocated regardless of the symptoms because of the potential morbidity and mortality from incarceration and strangulation [13, 25]. Type 4 hernias occur when other viscera including the colon, spleen, small bowel, and omentum herniate through the defect.

The surgical treatment of paraesophageal hernias remains a challenging problem. Whether approached through a laparotomy or thoracotomy, the optimal techniques for surgical repair are debated. Pertinent



**Fig. 1.** Chest x-ray showing gastric air bubble in the posterior mediastinum.

controversial issues include the need for complete excision of the sac, closure of the crural defect, assessment for adequate intraabdominal esophageal length, the need for an antireflux procedure, and the need for a gastropexy. This debate continues in the laparoscopic era.

The laparoscopic repair of paraesophageal hernias has been shown to result in the short-term benefits of reduced pain, hospitalization, and convalescence [17]. However, the ultimate measure of success for any hernia surgery is the absence of recurrence. Most laparoscopic reports are based necessarily on short-term follow-up periods. Importantly, this follow-up evaluation has been based primarily on symptomatic outcomes and not radiographic follow-up assessment. Recent reports have questioned the anatomic integrity of laparoscopic repair for paraesophageal hernias with radiographic follow-up evaluation documenting asymptomatic recurrence rates as high as 42% [11]. The purpose of this study was to determine the effect of adding an anterior gastropexy to the laparoscopic repair of paraesophageal hernias. Symptomatic and radiographic evaluations were performed to assess the anatomic integrity of the laparoscopic technique.

## Materials and methods

Between July 2000 and January 2002, one surgeon (J.P.) performed 28 consecutive laparoscopic repairs of large (type 3 or 4) paraesophageal hernias. Data were collected prospectively and included demographics, preoperative symptoms, radiographic and endoscopic findings, oper-



**Fig. 2.** Upper gastrointestinal series showing large type 3 paraesophageal hernia with organoaxial rotation.

ative details, intraoperative and postoperative complications, postoperative complaints, and long-term radiographic follow-up evaluation.

Routine preoperative evaluation included a complete history and physical examination, a chest x-ray (Fig. 1), an upper gastrointestinal series to define the hernia (Fig. 2), and flexible upper endoscopy to rule out other anatomic abnormalities. Because the gastroesophageal junction is anatomically distorted in type 3 paraesophageal hernias, esophageal pH testing and manometry often are unreliable, and therefore are not routinely obtained.

Follow-up assessment was performed at 3 months, 6 months, 1 year, and annually thereafter. Patients were interviewed and examined by a staff surgeon (J.P.). Evidence of reflux, dysphagia, gas bloat, and incisional pain were recorded. Additionally, patients underwent barium esophagram 24 h postoperatively, and then at each of the previously mentioned follow-up points. Anatomic recurrence was defined as evidence of a sliding hernia more than 2 cm above the level of the diaphragm.

## Surgical technique

The patient is positioned on a split-leg table with the arms tucked at the sides. The primary surgeon stands between the patient's legs, with the first assistant to the patient's left, and the camera operator to the patient's right. Routinely, five trocars are placed. The orientation is similar to that for a standard laparoscopic antireflux case, although the ports are placed slightly more cephalad to allow for mediastinal dissection if necessary.

The initial 10-mm Hasson trocar is placed in open fashion approximately 14 cm from the xyphoid process in the midline position (Fig. 3). After pneumoperitoneum is established, the remaining four trocars are placed under direct vision. The second 12-mm trocar is placed in the right upper quadrant just below the liver edge as far laterally as possible to prevent crowding of the remaining trocars. This

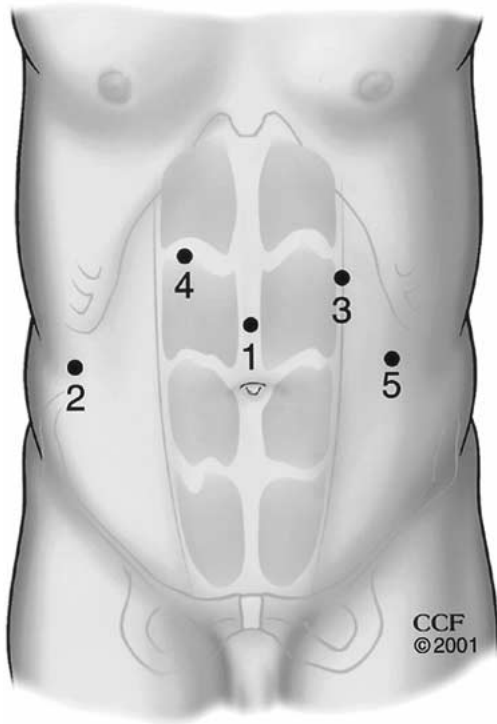


Fig. 3. Trocar placement.

trocar is used primarily to introduce an expandable liver retractor to expose the esophageal hiatus by retracting the left lobe of the liver. The two operating ports are placed in the left upper quadrant (5- to 12-mm Versaport, United States Surgical Corp. [USSC], Norwalk, CT, USA) and in the right upper quadrant of the midaxillary line (5 mm) for the surgeon's right and left hands, respectively. A final 5-mm trocar, placed approximately 5 cm below the left upper quadrant port, is used by the assistant for retraction of the gastric fundus during hiatal dissection.

The hernia contents are reduced into the abdomen with gentle retraction. The gastrohepatic ligament is opened with the ultrasonic dissector, exposing the right crus. The peritoneum is incised over the right crus with the ultrasonic dissector. Using blunt dissection, the surgeon pulls the hernia sac downward out of the thorax while pushing away mediastinal attachments. The sac is removed totally from the mediastinum, but not excised from its attachments at the gastroesophageal junction. The vagal nerves are carefully identified and preserved during the dissection. The crura are fully dissected and exposed. A retroesophageal window is created, and a penrose is passed around the gastroesophageal junction for retraction. With downward retraction on the penrose, the mediastinal attachments of the esophagus are completely dissected. Typically, this provides adequate esophageal lengthening. The crura are closed posteriorly using interrupted 0 silk sutures without pledgets. A bougie is not placed. When necessary, anterior crural stitches are placed. On one occasion, in a patient with a type 4 hernia, mesh was placed because the crura could not be closed, primarily because of excessive tension.

The antireflux procedure is performed by bringing a mobile segment of fundus through the retroesophageal window. If the fundus will not wrap around the esophagus without tension, the short gastrics are divided using the ultrasonic dissector. A posterior gastropexy is performed by anchoring the posterior stomach involved in the wrap to the crural closure. This is performed by placing a single silk suture from the posterior wrap to the crural suture line. A modified Toupet then is performed by placing two interrupted sutures on either side of the wrap anchoring the stomach to the esophagus.

The anterior gastropexy is performed by suturing the anterior stomach wall to the anterior abdominal wall at two sites using 0 silk sutures (Fig. 4A). A suitable site on the stomach is chosen that enables sutures to be passed below the costal margin and the stomach to be secured to the anterior abdominal wall. Each suture is introduced into

the abdomen and passed through the anterior stomach a few centimeters from the Toupet. A small incision is made in the anterior abdominal wall, and a suture passer brings both tails extracorporeally through separate fascial areas. After the pneumoperitoneum is released, these sutures are tightened, anchoring the stomach to the anterior abdominal wall (Fig. 4B).

Patients are placed on a liquid diet on postoperative day 1 after a Gastrografin swallow shows no leakage. The diet is advanced to soft solids for 2 weeks, and then to a regular diet as tolerated.

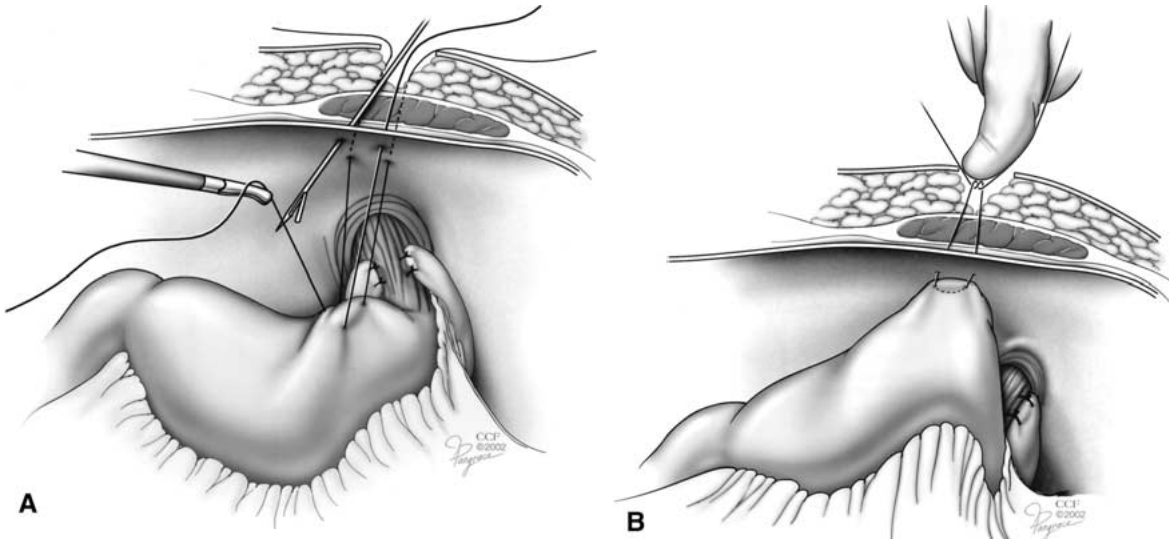
## Results

In this study, 7 men and 21 women ranging in age from 35 to 82 years, (average, 67 years) underwent elective laparoscopic repair of the paraesophageal hernia. The patients had a mean body mass index of 28 kg/m<sup>2</sup> (range, 20–55 Kg/m<sup>2</sup>), and tended to have significant comorbidities with an average American Society of Anesthesiology (ASA) classification of 3 (range, 2–4). Detailed questioning showed all patients to be symptomatic as a result of their hernia. The most common problem reported was postprandial discomfort (57%) including abdominal pain, bloating, nausea, or vomiting. Other problems included reflux (29%), dysphagia (18%), anemia (14%), early satiety (7%), and weight loss (7%). All the patients underwent a barium swallow, which showed a giant type 3 paraesophageal hernia with at least one-third of the stomach located above the diaphragm (Fig. 2A and 2B). Upper endoscopy showed esophagitis in nine patients (32%) and linear gastric ulcerations in four patients (14%). All biopsies showed normal results, with no evidence of Barrett's mucosa.

The mean operative time was 146 min (range, 101–186 min), and the mean estimated blood loss was 71 ml (range, 10–200 ml). In one patient, a large type 4 hernia was identified intraoperatively, with the transverse colon located in the hernia sac. Because of the large attenuated hiatal defect, primary closure without excessive tension was not possible. Single-ply GoreTex mesh (W.L. Gore, Flagstaff, AZ, USA) was placed in this patient to close the hiatal defect. The mesh was approximately 3 × 3 cm and fashioned as a horseshoe. It was secured to the crural edges with interrupted silk sutures. The remaining patients had type 3 hernias, and the crura were closed primarily. No patients underwent conversion to an open procedure.

A Toupet fundoplication was performed for 27 patients, and one patient had a Dor procedure. One intraoperative complication occurred. During dissection of an extremely adherent hernia sac, a small tear in the esophagus occurred. This was recognized immediately and repaired laparoscopically. A Dor fundoplication was performed over the repair. The patient recovered uneventfully.

The patients remained in the hospital for an average of 2 days (range, 1–14 days). Three postoperative complications (11%) occurred in two patients. Two patients reported transient postoperative dysphagia. One patient underwent upper endoscopy on postoperative day 7, and retained food debris was evacuated from the esophagus. The patient's dysphagia resolved. Another patient required endoscopic dilation of a narrow gastr-



**Fig. 4.** **A** Artist depiction of anterior gastropexy with sutures placed in the gastric body and a suture passer bringing the suture extracorporeally. **B** Completed anterior gastropexy.



**Fig. 5.** A 1-year postoperative barium study showing the subdiaphragmatic location of the stomach and intact fundoplication.

oesophageal junction. The patient's dysphagia resolved. One year later, the patient reported gas bloat symptoms, which resolved after treatment with erythromycin. No mortality occurred in this series.

Follow-up examination and radiologic evaluation was performed for all 28 patients. The average follow-up period for these 28 patients was 21 months (range, 3–24 months). All the patients experienced symptomatic relief. Routine barium esophageal studies on postoperative day 1 showed no leaks and no anatomic recurrences.

At this writing, all patients have completed one year follow-up evaluation with no symptomatic or anatomic

recurrences on barium studies (Fig. 5). Currently, 10 patients are available for 24-months follow up evaluation, and all have completed barium esophagram evaluation. No patients had anatomic recurrence of their hernia and all remain asymptomatic.

## Discussion

Most laparoscopic paraesophageal hernia repair studies have based their follow-up evaluation on symptomatic outcomes, and systematic radiographic studies are lacking [12, 17, 24, 29, 31]. These studies report recurrence rates of 0% to 5% with medium-term follow-up assessment. Because these patients can have large hernias without accompanying symptoms preoperatively, it seems reasonable not to rely on symptomatic outcomes postoperatively for evaluation of potential recurrences. Two laparoscopic series in which patients were evaluated postoperatively with radiographic studies recently reported high rates of asymptomatic anatomic recurrence. In the study by Hashemi et al. [11], gastropexy was not performed in any of the laparoscopic cases, and the recurrence rate was 42%. Wu et al. [33] reported a 23% rate of anatomic recurrence after their paraesophageal hernia repairs during a follow-up period of 3 months or more. They did not routinely perform sac excision, fundoplication, or gastropexy in their series. On the basis of these poor results, these authors concluded that anterior gastropexy and fundoplication should be performed in all laparoscopic repairs. A review of several large open series with long-term follow-up periods show recurrence rates of 7% to 11% for paraesophageal hernia repair [9, 18, 32]. If the laparoscopic approach is proposed as the method of choice for repair of a paraesophageal hernia, then the operative principles of the traditional open approach should be accomplished [3]. These principles include reduction of the hernia, complete sac excision from the mediastinum,

adequate crural closure, maintenance of a subdiaphragmatic esophagus, gastropexy, and an antireflux procedure [1, 6, 19, 30]. On the basis of our study, if these basic tenets are followed, the laparoscopic repair of paraesophageal hernias results in no recurrences with medium-term follow-up evaluation.

We have not encountered a paraesophageal hernia that could not be reduced without undue tension into the abdomen after adequate sac excision. No esophageal lengthening procedure was necessary in any of our patients. This supports the notion that adequate esophageal mobilization and complete sac excision with a gastropexy result in a satisfactory anatomic repair of these defects.

Maziak et al. [18] reported a large series of 94 consecutive paraesophageal hernia repairs performed over a 36-year period, in which 97% were approached through a left posterolateral thoracotomy. Esophageal length was determined preoperatively by endoscopic and manometric measurements, or intraoperatively by the excessive tension required to maintain an intraabdominal esophagus. According to the subjective and objective findings in this series, a Collis gastroplasty was performed in 80% of the cases. These investigators documented a 93% good to excellent result during a mean follow-up period of 94 months. Clearly, this is a standard that laparoscopic repair will have to match. These authors also reported two postoperative deaths, one of which was directly attributable to a leak in the staple line from the gastroplasty procedure. Dysphagia was reported in 13% of their patients as well. Therefore, the addition of an esophageal lengthening procedure must be weighed against the potential postoperative morbidity and mortality that may result.

A novel technique for performing a laparoscopic Collis gastroplasty was reported initially by Swanstrom et al. [27]. These authors performed a laparoscopic Collis gastroplasty in three patients with a "short esophagus" and noted no recurrences. Although a Collis gastroplasty certainly can be performed technically, we question whether it is truly necessary. With a complete sac excision and an anterior gastropexy performed in our series, we had no recurrences. Authors advocating treatment for a shortened esophagus believe this entity results from chronic reflux esophagitis, scarring, and the stomach being pulled into the chest. Typically, this type of scarring is a result of long, severe strictures. With the widespread use of proton pump inhibitors, this type of esophagitis currently is not common. In most of our patients, we suspect that the esophagus actually is being shortened because of the stomach pushing it up into the chest. Therefore, an esophageal-lengthening procedure is not necessary, and merely correcting the anatomic arrangement of the gastroesophageal junction should suffice. This is evidenced by the absence of recurrence in our series with its large paraesophageal hernias, in which no esophageal-lengthening procedures were required.

The need for an antireflux procedure and the most appropriate type of fundoplication are debated by many authors. Because of the extensive dissection necessary for full mobilization of the parahiatal region, the gastroesophageal junction may be rendered incompe-

tent, resulting in postoperative reflux symptoms [33]. Several authors have shown a 65% incidence of reflux symptoms after surgery in patients whose repair did not include fundoplication [23, 28]. Therefore, we believe that some type of antireflux procedure is appropriate. In our series, 29% of the patients reported preoperative reflux, whereas postoperative reflux was not an issue. Laparoscopic Toupet fundoplication has been proved effective in the treatment of reflux disease [20]. In the setting of paraesophageal hernia, Toupet fundoplication not only provides an adequate reflux barrier, but also anchors the fundus to the diaphragmatic crura to aid in the intraabdominal posterior pexy of the stomach. It is our experience that this anatomic correction of the gastroesophageal junction with the addition of a partial wrap improves reflux symptoms. In our series, transient postoperative dysphagia requiring endoscopic dilation developed in one patient. This is a somewhat lower incidence rate than previously reported. Studies in which a Nissen or Collis gastroplasty was performed have tended to experience higher rates of dysphagia [18].

Whereas there is universal agreement as to the necessity of crural closure, the optimal technique remains controversial. Several authors have advocated the use of mesh to close the crural defects in a paraesophageal hernia [3, 22, 31]. In contrast to inguinal or ventral hernias, the diaphragmatic hiatus contains a nonsensitized hollow viscous that risks erosions or stricturing as a result of the fibrotic response to mesh. Long-term follow-up assessment is necessary for adequate evaluation of their safety. One patient in our series required mesh for closure of the hiatal defect. This patient had a large defect with a type 4 hernia. Despite repeated attempts at primary closure of the defect, a tension-free repair could not be achieved. In these unusual circumstances, we do place mesh. However, we believe that the diaphragm usually can be closed primarily.

Although no prospective randomized studies have been performed to prove that anterior gastropexy or gastrostomy reduces reherniation rates, several authors have advocated their use as a possible means for reducing reherniation in both open [4, 9, 13, 21], and laparoscopic [5, 14–16] repairs of paraesophageal hernias. Because of the positive intraabdominal pressure and negative intrathoracic pressure, there is a constant tendency for reherniation of the stomach into the mediastinum. Anchoring the stomach posteriorly to the diaphragm and anteriorly to the abdominal wall should reasonably prevent this mechanism of reherniation. Moreover, if the crural closure becomes disrupted, the dual pexy of the stomach should enable it to maintain its anatomic position without reherniation and resultant organoaxial rotation risking gastric volvulus or strangulation. In the absence of a prospective randomized trial, a definitive conclusion about the effect of anterior gastropexy cannot be drawn. However, the absence of recurrence in our series suggests that the addition of an anterior gastropexy may result in a lower recurrence rate than previously reported in laparoscopic series.

Laparoscopic repair of paraesophageal hernias is technically demanding, requiring meticulous dissection of mediastinal structures. As with any advanced lapa-

roscopic procedure, a learning curve is required [7, 26]. We have performed more than 100 laparoscopic paraesophageal hernia repairs, and this study does not include our early experience. This study documents the safety and feasibility of laparoscopic paraesophageal hernia repair, showing that this approach may provide excellent results. As noted by several authors, most recurrences after open or laparoscopic repair of paraesophageal hernias occur within the first year [8, 9, 11]. In fact, all of the recurrences in a recent prospective randomized trial of 72 laparoscopic paraesophageal hernia repairs performed by Frantzides et al. [10] occurred within the first 6 months of a follow-up period that averaged slightly longer than 3 years. Thus, the recurrence rate should not change dramatically in our series as the patients undergo continued follow-up evaluation.

In conclusion, the data suggest that laparoscopic repair of paraesophageal hernias may obtained excellent results by combining reduction of the mediastinal sac, crural closure, fundoplication with posterior fixation, and anterior fixation by means of anterior gastropexy.

## References

- Allen MS, Trastek VF, Deschamps C, Pairolero PC (1993) Intrathoracic stomach: presentation and results of operation. *J Thorac Cardiovasc Surg* 105: 253–258, discussion, 258–259
- Allison P (1951) Reflux, esophagitis, sliding hiatal hernia, and the anatomy of repair. *Surg Gynecol Obstet* 92: 419–431
- Behrns KE, Schlinkert RT (1996) Laparoscopic management of paraesophageal hernia: early results. *J Laparoendosc Surg* 6: 311–317
- Boerema I (1969) Hiatus hernia: repair by right-sided, subhepatic, anterior gastropexy. *Surgery* 65: 884–893
- Congreve DP (1992) Laparoscopic paraesophageal hernia repair. *J Laparoendosc Surg* 2: 45–48
- Dahlberg PS, Deschamps C, Miller DL, Allen MS, Nichols FC, Pairolero PC (2001) Laparoscopic repair of large paraesophageal hiatal hernia. *Ann Thorac Surg* 72: 1125–1129
- Deschamps C, Allen MS, Trastek VF, Johnson JO, Pairolero PC (1998) Early experience and learning curve associated with laparoscopic Nissen fundoplication. *J Thorac Cardiovasc Surg* discussion, 284–285 115: 281–284,
- Edye MB, Canin-Endres J, Gattorno F, Salky BA (1998) Durability of laparoscopic repair of paraesophageal hernia. *Ann Surg* 228: 528–535
- Ellis Jr FH, Crozier RE, Shea JA (1986) Paraesophageal hiatus hernia. *Arch Surg* 121: 416–420
- Frantzides C, Madan A, Carlson M, Stavropoulos G (2002) A prospective randomized trial of laparoscopic polytetrafluoroethylene (PTFE) patch repair vs simple cruroplasty for large hiatal hernia. *Arch Surg* 137: 649–651
- Hashemi M, Peters JH, DeMeester TR, Huprich JE, Quek M, Hagen JA, Crookes PF, Theisen J, DeMeester SR, Sillin LF, Bremner CG (2000) Laparoscopic repair of large type III hiatal hernia: objective follow-up reveals high recurrence rate. *J Am Coll Surg* 190: 553–560, discussion, 560–566
- Hawasli A, Zonca S (1998) Laparoscopic repair of paraesophageal hiatal hernia. *Am Surg* 64: 703–710
- Hill LD, Tobias JA (1968) Paraesophageal hernia. *Arch Surg* 96: 735–744
- Johnson PE, Persaud M, Mitchell T (1994) Laparoscopic anterior gastropexy for treatment of paraesophageal hernias. *Surg Laparosc Endosc* 4: 152–154
- Kercher KW, Matthews BD, Ponsky JL, Goldstein SL, Yavorski RT, Sing RF, Heniford BT (2001) Minimally invasive management of paraesophageal herniation in the high-risk surgical patient. *Am J Surg* 182: 510–514
- Koger KE, Stone JM (1993) Laparoscopic reduction of acute gastric volvulus. *Am Surg* 59: 325–328
- Luketich JD, Raja S, Fernando HC, Campbell W, Christie NA, Buenaventura PO, Keenan RJ, Schauer PR (2000) Laparoscopic repair of giant paraesophageal hernia: 100 consecutive cases. *Ann Surg* 232: 608–618
- Maziak DE, Todd TR, Pearson FG (1998) Massive hiatus hernia: evaluation and surgical management. *J Thorac Cardiovasc Surg* 115: 53–60, discussion, 61–62
- Menguy R (1988) Surgical management of large paraesophageal hernia with complete intrathoracic stomach. *World J Surg* 12: 415–422
- Mosnier H, Leport J, Aubert A, Kianmanesh R, Sbai Idrissi MS, Guivarc'h M (1995) A 270-degree laparoscopic posterior fundoplasty in the treatment of gastroesophageal reflux. *J Am Coll Surg* 181: 220–224
- Nissen R (1960) Repair of para-esophageal hiatal hernia by fixation to the abdominal wall. In: Mulsoland (ed) *Current surgical management*, 2nd ed. WB. Saunders, Philadelphia, pp 58–69
- Paul MG, DeRosa RP, Petrucci PE, Palmer ML, Danovitch SH (1997) Laparoscopic tension-free repair of large paraesophageal hernias. *Surg Endosc* 11: 303–307
- Pearson FG, Cooper JD, Ilves R, Todd TR, Jamieson WR (1983) Massive hiatal hernia with incarceration: a report of 53 cases. *Ann Thorac Surg* 35: 45–51
- Perdikis G, Hinder RA, Filipi CJ, Walenz T, McBride PJ, Smith SL, Katada N, Klingler PJ (1997) Laparoscopic paraesophageal hernia repair. *Arch Surg* 132: 586–558, discussion, 590–591
- Skinner DB, Belsey RH (1967) Surgical management of esophageal reflux and hiatus hernia: long-term results with 1,030 patients. *J Thorac Cardiovasc Surg* 53: 33–54
- Soper NJ (1999) Laparoscopic management of hiatal hernia and gastroesophageal reflux. *Curr Probl Surg* 36: 765–838
- Swanstrom LL, Marcus DR, Galloway GQ (1996) Laparoscopic Collis gastroplasty is the treatment of choice for the shortened esophagus. *Am J Surg* 171: 477–481
- Treacy PJ, Jamieson GG (1987) An approach to the management of paraesophageal hiatus hernias. *Aust N Z J Surg* 57: 813–817
- Trus TL, Bax T, Richardson WS, Branum GD, Mauren SJ, Swanstrom L, Hunter JG (1997) Complications of laparoscopic paraesophageal hernia repair. *J Gastrointest Surg* 1: 221–228
- Watson DI, Davies N, Devitt PG, Jamieson GG (1999) Importance of dissection of the hernial sac in laparoscopic surgery for large hiatal hernias. *Arch Surg* 134: 1069–1073
- Willekes CL, Edoga JK, Frezza EE (1997) Laparoscopic repair of paraesophageal hernia. *Ann Surg* 225: 31–38
- Williamson WA, Ellis FH Jr, Streitz JM Jr, Shahian DM (1993) Paraesophageal hiatal hernia: is an antireflux procedure necessary? *Ann Thorac Surg* 56: 447–451, discussion, 451–452
- Wu JS, Dunnegan DL, Soper NJ (1999) Clinical and radiologic assessment of laparoscopic paraesophageal hernia repair. *Surg Endosc* 13: 497–502