Comparative Evaluation of Gastrointestinal Transit and Immune Response Between Laparoscopic and Open Gastrectomy in a Porcine Model

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Several reports have shown advantages of laparoscopic gastrointestinal (GI) procedures when compared with their open counterparts. The aim of this study was to assess the differences of GI transit and immune response between laparoscopic and open gastrectomy in a porcine model. Fourteen pigs were assigned to undergo partial gastrectomy, either by laparoscopy (lap group) or by laparotomy (open group). GI transit was assessed using 24 markers and measured until half of markers were evacuated. To assess immune response, we used delayed-type hypersensitivity skin antigen testing (DTH) with vaccine antigen. DTH was evaluated at 48 hours after the primary injection for induration. After 2 weeks, all animals underwent necropsy and were evaluated for adhesion formation using a scoring scale. Operation time was significantly longer in the lap group. The GI transit in the postoperative phase was significantly prolonged compared with the preoperative measured times. Postoperatively, the GI transit in the open group was significantly prolonged compared with the lap group. Immune response measured by DTH was better preserved in the lap group than in the open group. Adhesion formation was significantly less in the lap group. We concluded that laparoscopic gastrectomy resulted in faster bowel recovery and less immune suppression. (J GASTROINTEST SURG 2006;10:39–45) © 2006 The Society for Surgery of the Alimentary Tract

Advances and experiences in laparoscopic surgery have made it possible to perform complex surgical procedures, including complex gastric surgery.1 2 Evident benefits of laparoscopic procedures include better cosmesis, lesser postoperative pain, and faster recovery than conventional surgery. Efforts were made to compare the surgical stress response in different surgical procedures.3 5 Laparoscopic gastric surgery is still not widely adapted. This is attributed partially to the complexity of the procedure and to the controversy over the applicability of laparoscopy in malignancy.

After surgical trauma, the inflammatory cascade causes changes in the activity of a wide variety of chemical substances, including catecholamines, nitric oxide, glucocorticoids, the complement-coagulation cascade, the kinin-bradykinin system, cytokines (including tumor necrosis factor, and interleukins), eicosanoids (arachidonic acid and its derivatives; leukotrienes, prostaglandins, and thromboxanes), endotoxins, heat-shock proteins, platelet-activating factor, and macro radicals.6 8 These cascades may interact by stimulating and aggravating various other mechanisms of the inflammatory response, which may lead to circulatory dysfunction and multiple organ failure. This physiological response, influenced mainly by the magnitude of the surgical trauma, is influenced by several factors such as anxiety, operative time, pain, hemorrhage, and infection. To minimize the surgical-related stress, improvements in anesthetic and operative techniques were suggested. Considering the significantly lesser trauma to the upper abdominal wall, laparoscopic surgery seems to present more appealing possibilities with respect to
Several reports have shown more preserved immune function after laparoscopic intervention in comparison to open techniques. In a canine model, laparoscopic pancreatectomy demonstrated faster gastrointestinal (GI) transit and less stress response than open surgery. In another experimental model, Burpee et al. described a diminished stress response using delayed-type hypersensitivity (DTH) testing in laparoscopic liver resection when compared with open resection.

Laparoscopic surgery for early gastric cancer is gaining increased acceptance. Several case series have shown the objective advantages of laparoscopic gastrointestinal surgery. Nevertheless, stress responses and GI transit after surgery are still inadequately addressed. We hypothesized that laparoscopic gastrectomy is associated with earlier recovery of GI transit and a lesser degree of stress response when compared with its open counterpart.

MATERIALS AND METHODS

Experimental protocols were reviewed and approved by the Institutional Animal Care and Use Committee of the Mount Sinai Medical Center, New York, NY. Experiments were performed in 14 Yorkshire female pigs weighing 30 to 40 kg. The animals were randomly allocated into two groups. In the laparoscopic group (lap group), seven pigs underwent laparoscopic partial (distal) gastrectomy, and in laparotomy group (open group), seven other pigs underwent a similar procedure. The animals were housed in an animal facility 7 days before intervention. They were maintained nil per os 12 hours before intervention with ad lib access to water. On the morning of surgery, they were premedicated with intramuscular injections of tiletamine (Telazol, 4.4 mg/kg)/xylazine hydrochloride (2.2 mg/kg) and 0.004–0.04 mg/kg of atropin. In the operating room, an intravenous line with ringer lactate was started at 100 ml/hour. General anesthesia was induced with intravenous 20 mg/kg thiopental intravenously. After endotracheal intubation, anesthesia was maintained with intravenous 20 mg/kg thiopental intravenously. After endotracheal intubation, anesthesia was maintained with 1.0%–2.0% isoflurane and air/oxygen (FiO₂ = 0.50). Anesthetic methods and techniques were the similar in both groups. An antibiotic prophylaxis (intravenous amoxicillin, 7 mg/kg) was administered at the beginning of the procedure.

Five days before surgery, the preoperative baseline studies were performed in each animal for DTH skin testing and GI transit time. The anesthetic method was used in the same fashion.

Surgical Procedures

Laparoscopic group. Through a 10 mm skin incision in the supraumbilical area, a Veress needle was inserted and pneumoperitoneum was accomplished by insufflation with carbon dioxide up to 15 mmHg. A 12 mm diameter trocar was inserted through the incision, and a 30-degree laparoscope was introduced into the abdominal cavity. Four additional trocars were inserted under direct vision, including two 15 mm trocars in the right and left upper quadrant at the midclavicular line, one 12 mm trocar in the right of the lateral side, and one 5 mm trocar in the left side of the lateral abdomen (Fig. 1, A). An omentectomy was performed using

![Fig. 1. (A) Trocar placement for lap group; (B) skin incision for open group.](image)