Intraabdominal humidity and electromyographic activity of the gastrointestinal tract

Laparoscopy versus laparotomy

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Abstract. The purpose of this study was to observe electromyographic activity of stomach, small bowel, and colon during and early after identical laparoscopic and conventional operations to compare the operative trauma. In nine dogs a cholecystectomy was performed laparoscopically (n = 5) or by laparotomy (n = 4). Analysis of electromyographic activity focused on rhythm, frequency, and amplitudes of slow waves. Furthermore, oxygenation of blood and tissue, intestinal impedance, intraabdominal humidity, and temperature were documented to investigate their influence on slow waves. Open cholecystectomy caused an evident decrease of frequency and amplitude of colonic slow waves in comparison to laparoscopic cholecystectomy. Arrhythmic slow waves were observed only in the stomach during conventional cholecystectomy. Stomach and small intestine showed no significant difference of frequency and amplitude of slow waves in both operation groups. Intraabdominal humidity and intestinal impedance differed significantly in laparoscopy and laparotomy. Laparoscopic cholecystectomy proceeded with a minor abdominal trauma documented by smaller alterations of slow waves. This may be caused by reduced peritoneal desiccation.

Key words: Intestinal motility — Laparoscopic vs conventional cholecystectomy — Animal experiment

The general tendency in surgery to reduce operative trauma has supported the development of laparoscopic operation techniques [4]. Clinical studies report that laparoscopic operations cause less pain and lead to earlier mobilization and shorter hospital stay of the patients [5, 7, 9, 10, 16]. Early postoperative pulmonary function is less deteriorated after laparoscopic surgery [6, 9, 10]. Reduced formation of postoperative adhesions and shorter postoperative atony were observed in animal experiments [15, 17]. These data indicate that laparoscopic operations proceed with minor operative trauma. Alterations of gastrointestinal electromyographic activity during and after open surgery in dogs and humans correlated with the intensity of operative trauma [8, 11, 13, 14]. The purpose of our study was to compare the operative trauma of identical laparoscopic and conventional operations by analysis of perioperative electromyographic activity of the gastrointestinal tract. Moreover, the influence of possible pathogenetic factors like intestinal desiccation or hypothermia was investigated.

Materials and methods

In 9 mongrel dogs (body weight: 14–28 kg) 3 bipolar silver–silver chloride electrodes were implanted into the serosa of the distal antrum, the proximal jejunum, and the colon transversum. After 4 weeks of recovery a cholecystectomy was performed under general anesthesia with Ketanest and Trapanal. The myoelectrical activity of the gastrointestinal tract was registered intraoperatively and in the early postoperative period. Arteria femoralis and vena jugularis were cannulated for intermittent arterial and venous blood gas analysis.

In five dogs a conventional cholecystectomy was performed. The abdomen was opened via a right paramedian incision of 10 cm in length. A Clarke-type microcatheter (Licox system) for measurement of O2 partial pressure and an electronic microthermoelement (Licox system) were implanted into the jejunum. The gallbladder was dissected using a retrograde procedure after double ligation of the cystic artery and the cystic duct. The remaining four dogs underwent laparoscopic cholecystectomy. Both Licox microcatheters were implanted into a jejunal loop through an incision of 3 cm in length in the right lower abdomen. The incision was closed with a 20-mm trocar. After insufflation of a pneumoperitoneum a light source and a video camera were intro-
duced through an umbilical 10-mm trocar. Three additional trocars (5–10 mm) were inserted in the right upper abdomen under visual control of the video camera. The cholecystectomy was performed using a standard retrograde procedure, utilizing ligating clips for the cystic duct and the cystic artery. The gallbladder was then removed through the trocar in the right lower abdomen.

The electromyographic activity of the gastrointestinal tract was amplified and recorded with an eight-channel graphic plotter (Siemens-Elema mingograph 82). Time constant was 0.5 s, lower and upper cut-off frequencies were set at 0.01 Hz and 100 Hz. Recordings were performed in every dog before and after abdominal incision or insufflation of gas, after cholecystectomy, and 1, 2, and 3 h postoperatively. Each recording period lasted 20–30 min. Rhythm, frequency, and amplitude of the basic electrical activity, also called slow waves, were analyzed.

Arterial and venous O₂ and CO₂ partial pressures were analyzed using an AVL blood-gas analyzer. Humidity and temperature of the intraabdominal gas phase were measured electronically (Hygrotek 6400). The measuring element was introduced through a trocar or the paramedian incision into the abdominal cavity. Intestinal impedance was measured with a Siemens Direktrheograph 933 using the antral and jejunal electrodes. Electrical impedance is an indirect measurement of tissue dessication, because it represents water content of the measured tissue, which is affected by evaporation and tissue profusion. All parameters were registered immediately before or after the electromyographic recordings. All data are expressed as mean ± standard deviation. Data of slow waves, tissue oxygenation, temperature, humidity, and intestinal impedance are expressed as percentages referring to the initial levels as 100%. Statistical analysis was done using the Wilcoxon test.

**Results**

Only slow waves were observed during laparoscopic or open cholecystectomy. Alterations of slow waves occurred mainly after abdominal incision or gas insufflation. The cholecystectomy itself caused fewer alterations.

The course of frequency and amplitudes of gastric slow waves did not differ significantly between both groups. Arrhythmia could be observed only in the stomach during open operations (Fig. 1). Initial frequency of slow waves was 4.5 ± 0.53 cycles/min in the laparoscopic and 4.53 ± 0.73 cycles/min in the conventional group. In both groups frequencies decreased after coeliotomy or gas insufflation. They remained at reduced levels after open cholecystectomy in contrast to the laparoscopic group. Amplitudes of slow waves decreased about 40–60% after abdominal incision or insufflation of pneumoperitoneum and normalized at the end of the experiment in both groups.

The small intestine showed no significant differences in the basic electrical rhythm between laparoscopic and conventional cholecystectomy. Initial frequencies of slow waves were 15.9 ± 2.0 cycles/min for laparoscopic cholecystectomy and 16.34 ± 2.78 cy-