Original Article

Experimental Evaluation of Ileal Patch in Delayed Primary Repair of Penetrating Colon Injuries: An Animal Study

Hamid Reza Abbasi,1 Shahram Bolandparvaz,1 Hooman Yarmohammadi,2 Bita Geramizadeh,3 Nader Tanideh,4 Shahram Paydar1 and Seyed Vahid Hosseini,2 1Department of Surgery, Faghihi Hospital, Shiraz University of Medical Sciences, 2Gastroenterohepatology Research Center, Division of Colorectal Surgery, Department of Surgery and 3Transplant Research Center, Division of Pathology, Nemazee Hospital, Shiraz University of Medical Sciences, and 4Experimental Medicine Center of Vice Chancellor of Research (Animal Lab), Shiraz University of Medical Sciences, Shiraz, Iran.

Primary repair of traumatic colonic perforation is progressively gaining acceptance as the best method of management. However, when delayed, the risk of infection-related complications may increase. Here, we present a new method of repairing colon perforation in the presence of peritonitis. Acute colon injury was simulated in 22 German shepherd dogs. The dogs were randomly divided into two groups of 11 and after 24 hours they were operated on. The perforations were repaired by subserosal suture technique. In the first group (group A), ileal patch was used. In the other group (group B), the colon was closed by debridement and anastomosis. After 6 weeks, the repairs were assessed on the basis of survival, gross and histological assessments. Nine (82%) dogs in group A and six (56%) in group B survived. Ileal patch utilization significantly decreased the mortality rate (p < 0.05). The cause of death in two group A dogs and five group B dogs was peritonitis and intra-abdominal abscess formation. None of the surviving dogs showed evidence of anastomotic leakage or breakdown. Small bowel patch used in primary repair of colon injury in the presence of peritonitis may decrease the risk of postoperative infection-related complications and the mortality rate. [Asian J Surg 2006;29(4):223–6]

Key Words: penetrating colon injury, primary colonic repair, small bowel patch

Introduction

Surgical recommendations for managing post-traumatic colonic perforation have evolved over the previous decades. Before World War II, primary repair was the most common method of management. However, the decision to perform primary repair was not based on the type of injury, time from injury, amount of contamination or the colon’s condition. Therefore, it had high rates of morbidity and mortality. However, during World War II, after Oglivie reported dramatically less mortality with exteriorization or diversion of colon injuries, the management changed.1 This practice continued unchanged until the early 1980s, and was adopted after the war by civilian injury management.2 As time passed, frequent observation of complications of diversion and exteriorization...
increased the tendency to perform primary repair in specific situations. Several studies reported that primary repair could possibly be performed with greater frequency in individualized situations and the trends have now moved towards primary repair without colostomy. However, none of the authors suggested primary repair in patients who had delayed presentation (6–12 hours). The most important reason for this was the relatively feeble blood supply of the colon, compared with the small bowel. Recent studies have reported satisfactory results of primary colonic closure even in situations of injuries in the presence of delayed presentation, shock (≥4 units of blood transfusion within the first 24 hours) and associated injuries or peritoneal contamination.

The most common methods for primary closure of colonic injuries are primary repair after segmental resection or debridement. Although several authors have suggested primary repair even in the presence of delayed presentation, one must bear in mind that the risk of septic complications increases. When dealing with delayed presentations, in order to decrease postoperative infection-related complications, the method that is routinely performed is peritoneal lavage with Ringer’s lactate and antibiotics. A method for repairing severe duodenal injuries with contamination is jejunal serosal patching. The small bowel has a rich blood supply and, therefore, is capable of healing even in inflamed conditions like peritonitis and has a lower rate and possibility of leakage. These methods have been successfully used in severe contaminated injuries or peritonitis, mostly seen in delayed management. With these considerations in mind, the aim of this study was to determine the efficacy of small bowel serosal patch in delayed repairing of experimentally perforated colonic injuries and in the presence of peritonitis.

**Patients and methods**

This study was approved by the ethics committee of Shiraz University of Medical Sciences and the principles of laboratory animal care (NIH publication No. 86-23, revised 1985) were followed.

Twenty-two female German shepherd dogs weighing 15–20 kg were utilized. No preoperative bowel preparation, mechanical or drug, was used. The dogs were fasted from 12 hours prior to the operation and the abdominal area, which was the operation field, was shaved. General anaesthesia was induced by administration of intravenous thiopental sodium, 17 mg/kg of body weight and maintained by inhalation of halothane-oxygen through an appropriate endotracheal tube during the operation. Acepromazine maleate (2%), 1 mg/kg, was used as the analgesic during the operation. Under aseptic conditions, a midline laparotomy incision was made and a section of the ascending colon, approximately 10 cm distal to the ileocolic junction, was mobilized and brought out through the incision. A sagittal laceration, 2 cm in diameter or 50% of the circumference, was made on the antimesenteric border of the ascending colon. Afterwards, the colon was returned to the abdomen and the wound was closed. The dogs were taken to the recovery room and then to isolated rooms. Diazepam 1 mg/kg was given to all the dogs, and acepromazine maleate 1 mg/kg was used to induce a painless recovery period. Postoperatively, each animal received intramuscular penicillin–streptomycin, 500 mg every 6 hours for 7 days. Penicillin–streptomycin was chosen because of its broad-spectrum coverage and inhibition of bacterial growth in the colon. Twenty-four hours later, the abdomen was reopened, with techniques similar to the previous operation. The peritoneal cavity was irrigated thoroughly with Ringer’s lactate solution and the colon was exteriorized. The dogs were randomly allocated into two groups of 11. In the first group (group A), the perforation was repaired using a serosal surface patch of the adjacent distal ileum and sutured with 3/0 polyglactin (Vicryl Supa, Iran), using a simple continuous one-layer seromuscular technique. In the other group (group B), colon wounds were closed by a simple continuous nonlocking single layer technique. In situations where more than 50% of the circumference was necrotic (perforation diameter <0.5 cm), debridement was also performed. All the animals were kept fasted for 4 days and nutrition was provided intravenously. On the 5th postoperative day, diet was started and advanced to regular diet on the 7th postoperative day. On the 7th postoperative day, antibiotic therapy was terminated.

To determine the presence of wound infection, peritonitis, anastomotic breakdowns or other intra-abdominal complications, all animals were either autopsied immediately after death (two dogs in group A and five dogs in group B) or explored once more 6 weeks after closure. Therefore, all of them were reopened, using the same methods as in the previous operations, and the site of colonic repair was removed and histological evaluation was done by a pathologist who was blinded to the study.
All data were analysed using Fisher’s exact test, with \( p < 0.05 \) for significant levels.

**Results**

Two (18%) dogs in group A and five (45%) in group B died during the 6 weeks of follow-up, all in the first week. In the two group A dogs and in three group B dogs, the cause of death was leakage from the anastomosis and abdominal sepsis. In the two other dogs in group B, the cause of death was obstruction on the colonic side, without any evidence of leakage, and even with the presence of obstruction, the site of anastomosis had remained intact. In the surviving dogs 1 week postoperatively, reoperation revealed complete repair of colonic perforation. There were no colonic anastomotic breakdowns in the survivors of both groups and none demonstrated leakage from the colonic anastomosis. Mortality was significantly lower in group A \( (p < 0.05) \).

**Gross and histopathological examinations**

Gross examination at 6 weeks revealed absence of any sign of infection and that the ileal patches were still in place (Figure 1). Additionally, complete coverage of the neomucosa on the serosal surface of the patch was detected (Figure 2). Histological examinations revealed two distinct portions (Figure 3). The first, normal colonic tissue with normal columnar epithelial cells with typical regenerative pattern and new capillary formation with immature mesenchymal tissue was observed along the site of repair. And the other, normal ileal tissue was observed along the site of repair.
Discussion

The management of colon injuries has undergone major changes in the past decades. Routine colostomy for all colonic injuries post-World War II was gradually replaced by selective primary repair in the late 1970s and by routine primary repair in recent years. Recent studies have reported satisfactory results of primary colonic closure even in situations such as injuries in the presence of delayed presentation and associated injuries or peritoneal contamination. The data from our experimental study support the use of primary repair. Of the 22 dogs that underwent primary repair of colonic injuries in the presence of contamination, only five (23%) had evidence of anastomotic leakage or suture-line dehiscence, which, due to delayed repair in the presence of peritonitis, is an acceptable rate. Therefore, the data suggest that primary repair of the colon has satisfactory results even in the presence of infection.

Delayed treatment of colonic injuries has been considered to predispose to postoperative morbidity. Some studies have suggested a cut-off time of 12 hours after injury beyond which primary repair cannot be performed safely. However, recent studies have demonstrated that primary repair of civilian penetrating injuries of the colon is safe irrespective of the delay in presentation, and the risk of septic complications does not significantly increase. In our study, we also demonstrated the same results in delayed closure. Primary repair was performed after 24 hours and satisfactory results were obtained.

The most common methods used for primary closure are primary repair and resection or debridement and anastomosis. Jejunal serosal patching and expanded polytetrafluoroethylene (Gore-Tex; W.L. Gore Assoc., Flagstaff, AZ, USA) patching have been reported to be effective in surgical management of severe duodenal injuries. These methods have been especially useful in severe contaminated injuries or peritonitis, mostly seen in delayed management. However, none of the above-mentioned methods have been utilized in repairing colonic injuries. In this experimental study, we compared the results of ileal serosal patch with simple delayed primary repair of large contaminated colonic injuries. We observed that the healing was complete and no infection-induced patch dehiscence or intestinal adhesions to the patch were seen.

Based on this experimental study, it can be concluded that ileal patch can be used in the repair of experimental colonic injuries. It may be the preferred approach in dealing with delayed perforations, but further experimental studies are warranted before its clinical application can be confirmed.

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References