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The research progress of acute small bowel perforation

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ABSTRACT

This article reviews the various aetiologies of small bowel perforations and their management. In addition to the well-known aetiologies such as trauma, inflammation and circulatory disorders, several new causes of small bowel perforation have been described in recent years. The spectrum reaches from iatrogenic perforations during laparoscopic surgery or enteroscopies to drug-induced perforations with new anti-cancer agents. The management of small bowel perforations requires a concept consisting of the safe revision of the leaking bowel and the treatment of the peritonitis. Depending on the local situation and the condition of the patient, several treatment options are available. The surgical management of the bowel leak can range from a simple primary closure to a delayed restoration of bowel continuity. When the condition of the bowel or patient is frail, the risk of a failure of a closure or anastomosis is too high, and the exteriorization of the bowel defect as a primary measure is a safe option. The treatment of the peritonitis is also dependent on the condition of the patient and the local situation. Early stages of peritonitis can be treated by a simple peritoneal lavage, either performed by laparoscopy or laparotomy. Severe forms of peritonitis with multi-organ failure and an abdominal compartment syndrome need repeated peritoneal revisions. In such cases, the abdomen can only be closed temporarily. Different technical options are available in order to overcome the difficult care of these patients.

1. Introduction

Small bowel perforation is a well-known, but not very common cause of an acute abdomen. The estimated incidence in one study was 1 in 300 000–350 000[1]. How often an emergency unit has to deal with this problem depends on the regional situation of a hospital. In our own busy institution, we observed from 1992 to 2005, 66 (26%) small bowel perforations out of 256 intestinal perforations.

Intestinal perforations are still a major challenge for the involved medical personnel. Since the time factor plays an important role for the survival, a highly motivated team is necessary to handle this life-threatening condition.

In the past, several innovations in the surgical management have been published. However, the superiority over the conventional methods is still under investigation.

2. Causes of small bowel perforation

Various aetiologies can cause a perforation of the small bowel (Table 1).

2.1. Trauma

Penetrating injuries after stabbing or gunshots are daily business in emergency rooms of big cities all over the world. Gunshots with pellets of lead or soft iron can occur as a serious hunting accident. In particular, when the shot comes from a short distance, myriads of pellets can perforate the bowel. The removal of the pellets and the repair of the damaged bowel can take many hours.

Non-penetrating injuries occur during traffic accidents usually in combination with other intra-abdominal injuries, such as liver and spleen rupture. A common blunt injury is caused by the handlebars of bicycles.

2.2. Foreign bodies

Penetration of the bowel can also occur from the inside: ingested toothpicks perforating the intestine are a life-

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Table 1
Various aetiologies of the small bowel perforation.

Causes of small bowel perforation	Specific forms
Trauma	Shot, stab, explosives, blunt injury
Foreign bodies	Toothpicks, fishbone, magnetic toys
Iatrogenic	Laparoscopy: Veress-needle, trocar, diathermy, instruments
	Enteroscopy
	Peritoneal dialysis
Irradiation	
Bowel obstruction	Strangulation
	Volvulus
Inflammatory diseases	Crohn's disease
	Tuberculosis
	Typhoid fever
	Actinomycosis
	Ascaridiasis
	Cytomegaly infection
Vascular problems	Mesenteric embolism
	Mesenteric thrombosis
	Vasculitis
Drugs	Nonsteroid antiinflamatory drugs
	Steroids
	Oral contraceptive pills
	Potassium chloride
	Iron
	Cocaine. Crack
	Cytotoxic chemotherapy
	Bevacizumab
	Tocilizumab
	Ipilimumab
	Temsirolimus
	Cetuximab
	Sunitinib
Tumours	Primary tumours: lymphoma, adenocarcinoma, angiosarcoma
	Metastatic tumours: melanoma, mesothelioma, breast cancer, lung cancer
Congenital anomalies	Meckels diverticulum
	Ileal or jejunal duplication
Craft versus host reaction	Acute intestinal craft versus host disease after bone marrow transplantation

threatening condition with a mortality of 9.6%[2]. In this study, 54% of the patients were not aware of the incident. In 30% of the patients, the toothpick could be removed by endoscopy. This was only possible in localizations reachable for gastroscopes or coloscopes. Fishbones, chicken bones, needles and safety pins have also been described as a cause of perforation. In children, magnetic toys have been recognized as a serious hazard. When magnetic particles are ingested together with another magnet, or with a metal foreign body, the magnetic power can cause a bowel wall necrosis with perforation. In USA, the Consumer Safety Commission has become aware of this problem since 2003. Several products have been recalled from the manufacturers since then[3].

2.3. Iatrogenic causes

Laparoscopic surgery needs for imaging and instrumentation ports which are inserted through the abdominal wall by means of trocars. Despite of several safety measures, a bowel perforation is always possible. When such a perforation is not discovered immediately by the surgeon, the diagnosis might be difficult in the postoperative setting, because the symptoms of the consecutive peritonitis can be obscured by postoperative pain. In a large study, van Voort found 0.13% perforations under 329 935 laparoscopic operations[4]. From these, 56% comprised the small bowel. The perforation was caused in 46% by a trocar or Veress-needle for producing a pneumoperitoneum; in 26%, it was caused by diathermy or laser. The mortality of bowel perforation during laparoscopy was 3.6%. Umbilical piercing has been described as a particular risk factor for establishing a pneumoperitoneum leading to small bowel perforation due to adhesion formation between bowel and anterior abdominal wall[5].

Another new problem is the perforation during an enteroscopy. Long enteroscopes are now used for the discovery of obscure intestinal bleeding sites and other rare conditions. In order to advance the enteroscope through the small bowel, two balloons are alternatively inflated, a potential hazard for perforation.

The insertion of catheters for peritoneal dialysis can lead to bowel perforation. Laparoscopic techniques have been advocated to minimize this risk factor[6].

2.4. Irradiation

Inadvertent irradiation of the small bowel has been a problem in the past. In particular, the irradiation of tumours of pelvic organs has a high risk of small bowel damage. New radiation techniques minimize this risk in modern radiation therapy.

2.5. Bowel obstruction

Ischaemia is the main cause of perforation as a consequence of bowel perforation. Local pressure or the strangulation of the mesentery is the most common mechanism.

2.6. Inflammatory bowel disease

Crohn's disease has been described in several studies as a major cause of small bowel perforation. Although the inflammatory process usually leads to a thickening of the bowel wall and the progression results rather in fistula formation, free perforation can occur. In addition to the inflammatory process, other factors can contribute to a perforation. Medications such as corticosteroids and monoclonal antibodies may play a role. Perforations have been described after diagnostic procedures such as capsule endoscopy, when the capsule is caught in a stricture. Endosopic dilatation of a stricture with a balloon can also lead to a perforation.

Infections such as typhoid fever and tuberculosis are common causes of bowel perforation in developing countries.

2.7. Drugs

New anticancer drugs can inhibit angiogenesis of tumours successfully, but in some cases a bowel perforation may occur. Bevacizumab has been shown to cause bowel perforation in 1%–4%[7], when used for chemotherapy for colon cancer, ovarian