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The effect of fluid overload in the presence of an epidural on the strength of colonic anastomoses

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ABSTRACT

Background: Despite the beneficial effects of epidurals in intra-abdominal surgery, the incidence of anastomotic leak remains controversial when used. Moreover, studies have also shown that fluid overload may be deleterious to anastomoses. The purpose of this paper is to evaluate the effects of varying intraoperative fluid protocols, in the presence of an epidural, on the burst pressure strength of colonic anastomoses.

Methods: An epidural was installed in 18 rabbits, divided into three groups. Group 1 received 30 mL/kg/h Ringer's lactate, Group 2 received 100 mL/kg/h Ringer's lactate, and Group 3 received 30 mL/kg/h Pentaspan. Two colo-colonic anastomoses were performed per rabbit. On postoperative day 7 the anastomoses were resected and their burst pressures measured as a surrogate for anastomotic leak.

Results: When comparing the average burst pressures of all three groups, there was a significant difference ($P = 0.04$). The anastomoses in the 100 mL/kg/h Ringer's lactate group were shown to be the weakest, with 64% of the anastomoses having burst under 120 mm Hg. The rabbits hydrated with Pentaspan had the highest strength, with no anastomoses bursting under 120 mm Hg. This translated into significant burst pressure differences ($P = 0.02$) between Group 2 and Group 3.

Conclusion: These results suggest that fluid overload with a crystalloid, in the presence of an epidural, may be deleterious to the healing of colonic anastomoses, creating a higher risk of anastomotic leak. Intraoperative resuscitation should thus focus on goal-directed euvolemia with appropriate amounts of colloids and/or crystalloids to prevent the risk of weakening anastomoses, especially in patients with epidurals.

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1. Introduction

Anastomotic dehiscence is a major postoperative complication and contributes greatly to patient morbidity and mortality. There are several risk factors that are associated with colonic anastomotic leak. These include patient factors such as malnutrition, steroid use, tobacco and alcohol use, leukocytosis, cardiovascular disease, ASA score, and diverticulitis. Operative factors include a low anastomosis (especially in an obese male), operative time >2 h, bowel obstruction, blood supply to the anastomosis, perioperative blood transfusion, and intraoperative septic conditions [1,2]. The effects of an epidural on such an anastomosis remain unclear, with conflicting results in the literature.

The benefits of perioperative epidural anesthesia and analgesia in abdominal surgeries have been clearly demonstrated [3]. An epidural has been shown to decrease the physiological response to the surgical stress imposed [3,4]. It has also been shown to improve the control of postoperative pain [3,5–11], decrease the duration of paralytic ileus [4,5,7–10,12], and decrease the risk of pulmonary complications [13]. Some studies have even demonstrated decreases in deep vein thrombosis [14], decreases in the risk of cerebrovascular events [3], and decreases in the incidence of myocardial infarct [3].

Despite these beneficial effects, some studies imply that epidurals may increase the risk of anastomotic dehiscence [5,15]. Small human studies have suggested that epidurals can lead to decreased colonic blood flow [16] and decreased oxygenation-perfusion at the site of the anastomosis [17], whereas other studies have shown improved blood flow with epidurals [18].

Human studies have never been able to show statistically significant results with regard to epidural analgesia/anesthesia and anastomotic dehiscence. The main reason for this is that in order to answer this question in a randomized clinical trial, more than 1037 patients in each group would be needed to demonstrate an increased risk of anastomotic leakage from 3.4% to 6.0% with 80% power and 2alpha = 0.05 [15]. Due to this challenge, multiple animal studies have been performed in an attempt to better understand the physiology and effect of an epidural on the healing of a colorectal anastomosis.

In a porcine model by Schnitzler *et al.* [19], epidural anesthesia and analgesia showed an increase in colonic transit time but no difference in blood flow, burst pressures, or hydroxyproline content in colonic anastomoses when compared with those receiving a sham epidural with a saline infusion. Jansen *et al.* [20] confirmed that colonic contractility in rats was increased with an epidural; however, their study also showed that the collagen I content was higher in those with an epidural and once again had similar burst pressures when compared with a group with a sham epidural. In a rabbit study by Adanir *et al.* [21], burst pressures were higher in those rabbits with an epidural and hydroxyproline and collagen content was the same when compared with rabbits with a sham epidural (saline infusion). Similar results were shown in a study done on dogs by Blass *et al.* [22].

Perioperative fluid management has been of increasing interest in the anesthesia literature, suggesting that restrictive or goal-directed fluid protocols may be more beneficial than liberal perioperative fluid resuscitation in abdominal surgeries [23–26] and that colloids may be more beneficial than crystalloids for postoperative outcome and the integrity of an anastomosis [27–29].

Our hypothesis is that when an epidural is in place, intraoperative fluid resuscitation is often required to counteract the hypotension caused by the epidural. This leads to a more liberal resuscitative approach, often with crystalloids, calling into question the effect fluid overload may have on a colonic anastomosis. To better understand this phenomenon, and in an attempt to clarify the debate about the effect of an epidural on colorectal anastomoses, an animal model was studied. The purpose of this study was to evaluate the effects of varying intraoperative fluid protocols, in the presence of an epidural, on the burst pressure strength of colonic anastomoses and, thus, on anastomotic healing.

2. Methods

2.1. Settings and animals studied

This study was performed at the Surgery Research Laboratory at the Maisonneuve-Rosemont Hospital, a tertiary care center of the Université de Montréal in Montreal, Quebec, Canada. This study was conducted in compliance with the standards set by the Canadian Council on Animal Care and was approved by the hospital's Research Ethics Board. It included male albino New Zealand rabbits weighing approximately 2.5 kg each. Rabbits were preferred because of the presence of tenia coli on their colons (absent in rats and pigs). The tenia coli is a longitudinal, smooth muscular layer also found in humans, and is important in the tensile strength of colo-colonic anastomoses (CCA) [30].

2.2. Preoperative care

Twenty-five rabbits were housed in individual cages and allowed unlimited access to food and water. A 4- to 7-d presurgical acclimatization period was provided prior to the experiment. Rabbits were allowed to have a regular diet up until surgery. No fasting period was employed. All rabbits were given antibiotic prophylaxis (Potensulf, 4% Trimethoprim/20% Sulfadoxine, [Bimeda Canada Inc, Cambridge, ON, Canada]), beginning the day of surgery preoperatively and then daily for 2 more doses postoperatively.

2.3. Anesthesia/epidural and analgesia

The same surgeon performed all of the procedures. Following sedation with midazolam (1 mg/kg), administration of glycopyrrolate (0.01 mg/kg), and analgesia with butorphanol (0.25 mg/kg), induction was performed with ketamine (10–30 mg/kg, depending on shaving time). Anesthesia was maintained with oxygen, nitrous oxide, and 2–4 minimal alveolar concentration of isoflurane *via* a mask. The lumbar