How to Apply a Bioresorbable Hyaluronate Membrane for the Prevention of Postoperative Adhesions in Horses

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Postoperative intra-abdominal adhesions are a significant complication of horses undergoing abdominal surgery, intestinal resection, and anastomosis for intestinal diseases. The use of a bioresorbable, hyaluronate (HA-) membrane may reduce the morbidity and mortality associated with surgical intestinal diseases in horses. Specific indications, method of application, and advantages and disadvantages of using HA-membranes in horses are discussed. Author's address: Department of Large Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, Athens, GA 30602.© 2001 AAEP.

1. Introduction

Intestinal diseases requiring surgical intervention remain significant problems in horses admitted to referral hospitals for acute abdominal pain. Adhesion formation is a significant cause of postoperative intestinal obstruction in horses undergoing abdominal surgery and intestinal resection and anastomosis for small intestinal diseases. Adhesions become a clinical problem when they compress or anatomically distort the intestine. This may lead to intestinal constriction, incarceration, or volvulus, predisposing the patient to intestinal obstruction and signs of abdominal pain, often requiring repeat celiotomy or euthanasia. Numerous clinical trials and laboratory investigations have been devoted to determining methods of minimizing the formation of postoperative intra-abdominal adhesions. Broad-spectrum antibiotics, non-steroidal anti-inflammatory agents, heparin, intra-peritoneal administration of high molecular weight solutions, omentectomy, and postoperative peritoneal lavage have all been advocated to minimize adhesion formation. Despite advances in surgical techniques and pharmacologic therapy, horses in which adhesions form after surgery have a high incidence of recurrence of adhesions and poor prognosis for survival.

A bioresorbable hyaluronate-carboxymethylcellulose membrane (HA-membrane) has been developed to reduce postoperative adhesion formation in humans. The flexible HA-membrane is applied to the serosal surface of the intestine or parietal peritoneum, forming a temporary protective barrier against serosal–serosal or serosal–peritoneal adhesion formation during early postoperative healing. Following application the membrane hydrates to a gel that adheres to tissues and most surfaces. It remains at the site of application for up to 7 days to separate adhesiogenic surfaces and is then cleared from the abdominal cavity by peritoneal macro-
phages. It is completely eliminated from the body by 28 days. In a prospective multicenter study, use of the HA-membrane decreased the incidence of postoperative adhesions from 94% to 51% in people undergoing abdominal surgery for a colectomy and diverting-loop ileostomy. Similarly, the HA-membrane has been shown to significantly reduce postoperative adhesion formation in horses. Furthermore, use of the HA-membrane caused no adverse effects on intestinal or peritoneal healing.

More recently, the HA-membrane has been demonstrated to facilitate small intestinal anastomoses in horses. Use of an HA-membrane in combination with a continuous single layer appositional suture pattern results in an anastomoses that provides larger stomal diameters and reduced surgery times as compared to conventional, two-layer, inverting anastomoses. This technique also minimizes the incidence of perianastomotic adhesion formation.

We routinely use 1–2 HA-membranes in horses undergoing exploratory celiotomy that are at an increased risk of postoperative adhesion formation (devitalized intestine requiring resection and anastomosis, focal adhesion formation in which adhesiolysis was subsequently performed, or focal areas of intestinal inflammation). We feel that use of the HA-membrane in horses at an increased risk of adhesion formation may reduce the morbidity and mortality associated with small intestinal surgical diseases in horses. Most questions regarding the use of HA-membranes concern application and retention of the membrane to the specific site of application. This presentation will address these two questions and present our clinical experience using the HA-membrane.

2. Materials and Methods

The HA-membrane we use is commercially available as a sterile $12.7 \times 15.2$ cm sheet. It is supplied in an outer trilaminate sealed pouch within an inner Tyvek sleeve and non-adherent holder (Fig. 1). It may be stored at room temperature.

The HA-membrane is used as an adjuvant in abdominal surgery for reducing the incidence, extent, and severity of postoperative adhesions at the site of placement. The surgical lesion is addressed and corrected and HA-membranes applied to potentially adhesogenic surfaces just prior to abdominal closure.

Site Preparation

For optimal results, the desired site of application should be dry and free of blood or debris. The site is elevated and exteriorized from the abdominal cavity and held by an assistant. Any excess fluid is thoroughly aspirated and the intestinal serosal surface and adjacent mesentery are gently patted dry with dry $4 \times 4$s or laparotomy sponges (Fig. 2).
HA-Membrane Application

The trilaminate pouch is opened immediately prior to application and the interior polyolefin sleeve containing the HA-membrane within a non-adherent holder is placed on the sterile field. The non-adherent holder containing the HA-membrane is removed from the polyolefin sleeve. If a specific shape or size of membrane is needed, it may be cut with scissors at this time. The membrane should be cut to the desired shape while it is still contained within the holder. We usually cut each membrane into half longitudinally. The narrower pieces conform more readily to small intestinal serosal surface and mesentery, and allow easier manipulation of the membrane. The HA-membrane is self-adherent and will readily stick to any moist surface, therefore the membrane should not be removed from its non-adherent holder until final application.

The HA-membrane is positioned directly at the site of application and allowed to adhere in the desired position by exposing 1–2 cm of the membrane through the open end of the holder and gently pressing the membrane onto the serosal surface of the intestine with a dry gloved hand or instrument (Fig. 3). The holder is then gradually withdrawn as more of the membrane is adhered to the intestinal surface. It is important to extend the membrane sufficiently beyond the margins of the affected area, and in the case of the intestine, to completely cover the adjacent mesentery (Fig. 4). When using multiple membranes there should be sufficient overlap of individual membranes to ensure continuous coverage of the affected tissue surface. No sutures or adhesives are necessary to secure the membrane to the affected tissue.

If unintentional tissue contact and adherence occurs, moderate irrigation with physiologic saline or lactated Ringers solution may be used to gently dislodge the membrane from unintended tissue surfaces. Gentle irrigation may also be used to facilitate coverage around variable contours of tissues or organs. Once in place, care should be taken not to disturb the membrane. The affected tissue is re-
turned to the abdominal cavity and the incision closed routinely.

Specific Applications
We routinely use HA-membranes in areas of localized serosal or peritoneal trauma that are at an increased risk of postoperative adhesion formation. Such areas would include focal areas of intestinal inflammation; segments of intestine that have been vascularly compromised, but deemed viable by subjective or objective measures; and focal adhesion formation in which adhesiolysis was subsequently performed. Additionally, HA-membranes are used to facilitate small intestinal and small colon anastomoses in foals and adult horses.

3. Results
We have used the HA-membrane in 22 clinical cases (20 horses and 2 foals) from 1998–2000 with excellent results. Eighteen horses had ischemic small intestinal lesions, one horse had a strangulating lipoma involving the small colon, and one horse had a cecal impaction requiring typhlectomy and evacuation. Both foals had a jejunal intussusception that required resection and anastomosis. In all of the horses the surgeon’s assessment was that the horse was at an increased risk of developing postoperative intra-abdominal adhesions. Sixteen of twenty horses (80%) and both foals survived and are presently alive. Our clinical impression from these cases is that use of the HA-membrane has decreased the morbidity and mortality associated with ischemic intestinal diseases in horses.

These clinical impressions are supported by recent experimental studies in which use of the HA-membrane significantly decreased the severity and incidence of experimentally induced intra-abdominal adhesions in horses. Furthermore, in a similar study use of the HA-membrane in horses caused no adverse effects on intestinal or peritoneal healing. Similarly, we have not observed any adverse effects from use of the HA-membrane in our clinical cases.

4. Discussion
Advances in anesthesia and surgery have made surgical treatment of small intestinal diseases in horses more common in private and academic equine referral hospitals. Despite improvements in diagnostic, anesthetic, and surgical techniques, long-term survival rates for horses with small intestinal diseases requiring surgery only approach 60–70%. The formation of postoperative intra-abdominal adhesions, resulting in intestinal obstruction and recurrent abdominal pain, significantly contributes to the unacceptably low survival rates in these horses.

The primary method of minimizing postsurgical adhesions continues to be a meticulous, atraumatic, surgical technique. However, the presence of preexisting peritoneal inflammation and the inherent invasive nature of surgery limits our potential for adhesion prevention in horses. Numerous clinical trials and laboratory investigations have been devoted to determining methods of minimizing the formation of intra-abdominal adhesions. Most recently, the development of a bioresorbable HA-membrane has provided a site-specific method of minimizing adhesion formation. The membrane is applied directly to potentially adhesiogenic tissue surfaces and prevents adhesion formation by sepa-
rating serosal surfaces during the early postoperative healing period. The ease of application, ability for accurate, site-specific placement, and proven experimental efficacy and safety are advantages of HA-membranes for adhesion prevention. Potential disadvantages include the relatively small size of the membrane, necessitating several membranes to cover a large area of affected tissue, and the cost (approximately $125 per sheet).

Our clinical experiences concerning the use of HA-membranes in horses have paralleled the results of experimental studies evaluating the efficacy and safety of these techniques. Postoperative intra-abdominal adhesions are a significant complication of horses undergoing abdominal surgery and intestinal resection and anastomosis for intestinal diseases. We believe the use of bioresorbable, hyaluronate membranes may reduce the morbidity and mortality associated with surgical intestinal diseases in horses.

References and Footnotes


*Seprafilm™, Genzyme Biosurgery Corporation, One Kendall Square, Cambridge, MA 02139.*