



## Efficacy of Polypropylene Mesh Coated with Bioresorbable Membrane (Sepramesh) for the Repair of Abdominal Wall Defects in Horses

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### Abstract

**Objective:** The aim of this study was to compare the use of Polypropylene mesh (Prolene) and Sepramesh, a coated Polypropylene mesh with a protective layer of Seprafilm on its visceral side, for the repair of abdominal wall defects in horses. We also aimed to quantify the consequent visceral adhesion and tissue inflammation.

**Study Design:** Experimental study.

**Animal Population:** Ten horses.

**Methods:** The horses were divided into the control group, where a 4×8 cm defect was created through the midline of the abdomen and repaired with polypropylene mesh, and the experimental group, where the same defect was made and closed sepramesh. Both meshes were placed intraperitoneally and sutured to the cut margins of peritoneum and the opponeurosis of external abdominal oblique muscle contacting in viscera in a tension-free technique.

**Results:** The severity and extent of adhesions were significantly lower in the experimental group (B) than the control group (A) ( $P < 0.05$ ). Horses that received a

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Polypropylene mesh experienced higher levels of inflammation, both on the day of operation and at two weeks, but significant differences were not apparent after 4 weeks.

**Conclusions:** This study confirmed the advantages of Sepramesh over Polypropylene mesh in the repair of abdominal wall defects in horses.

**Clinical Relevance:** There are many causes of abdominal wall defects in horses, including congenital and traumatic. This experiment suggests that the use of Sepramesh could strengthen the healing of abdominal wounds, prevent incisional hernias, and reduce intraabdominal adhesions.

**Key Words:** Horse; abdominal wall defect; hernia; polypropylene mesh; Sepramesh; adhesion.

## Introduction

Surgical repair of abdominal hernias, such as umbilical, inguinal, scrotal and incisional hernias, is a common procedure in domestic animals. However, incisional herniation has been reported to recur occasionally after repair, and for those that do not occur, postoperative complications, such as local inflammation, wound discharge, and morbidity associated with the repair are relatively frequent. Additionally, the tension-producing techniques, such as vest over pants and modified mayo, are more often associated with serious intraoperative complications, such as bleeding, so much tension on suture line and not approximation of fascia edges, than those are tension-free repair techniques, although such complications are infrequent.<sup>1</sup> Since the introduction of prosthetic meshes to provide tension-free repair of hernias, have decreased recurrence rates, and animals that have undergone repair of a hernia have returned to normal activities more quickly than those treated with the traditional, tension-producing techniques, with prosthetic meshes, defects of the abdominal wall of almost any size can be repaired with a little complications.<sup>2</sup>

In one study, the use of both sepramesh (Genzyme) and seprafilm (Genzyme) was effective in reducing the adhesions between polypropylene mesh (Prolene) and the underlying viscera in rats, but the influence of these materials on the formation of inflammation as a result of trauma produced by surgery was not evaluated.<sup>3,4</sup> Esfandiari and Nowrouzian (2006) reported favorable results with the combined application of Sepramesh and Seprafilm in a “sandwich” technique by placing the peritoneum between these two materials during the repair of abdominal wall hernias in mice. They reported that the combined application reduced, and in some instances prevented, tissue adhesion and markedly decreased tissue inflammation after repair of abdominal wall defects, compared with those of either prosthetic material implemented separately.<sup>3</sup>

We can find no reports describing the use of these prosthetic materials to repair abdominal hernias of horses or other domestic animals. The aim of this study was to evaluate the efficacy of Sepramesh in the repair of abdominal wall defects in horses. Furthermore, we aimed to quantify the visceral adhesions and tissue inflammation after repair of hernias using either polypropylene mesh or Sepramesh. We hypothesize that using Sepramesh to repair an abdominal wall defect would result in fewer adhesions and less inflammation than would using polypropylene mesh.

## **Materials and Methods**

### *Animals*

The 10 horses used in this study suffered from severe and chronic orthopedic or neurological diseases, were non-responsive to therapy, and had been designated for euthanasia for those reasons. The horses were divided into two groups of five horses each (group A and B). Horses in group A, received polypropylene mesh (Marlex, Bard Benelux, Nieuwegein, and the Netherlands), and horses in group B received Sepramesh (Genzyme, Cambridge, MA).

### *Health Monitoring*

Horses were determined to be free for ectoparasites, and other infectious diseases, including strangles, glanders and equine influenza by the Diagnostic Laboratory of the Educational and Research Hospital, Faculty of Veterinary Medicine, University of Tehran. The horses appeared to be healthy as determined by physical examination and serological testing for various diseases, and they were treated with an antihelminthic drug against the endoparasite before surgery.

### *Preoperative Procedure*

The horses were fasted for 18 hours and denied water for 12 hours prior to surgery. Horses were weighed, groomed, washed, and dried. Their shoes were removed and their hoofs were cleaned. The surgical area was clipped and shaved while that horse was in the standing position. Vital signs, such as heart rate, respiratory rate, and capillary refill time (CRT) and body temperature were recorded. Procaine penicillin G 3000000 IU, (11000 IU/kg) intramuscularly (IM) and one dose of phenylbutazone (4.4 mg/kg) intravenously were administered before surgery separately. The horses were tranquilized with diazepam (0.22 mg/kg), and after 20 min, anaesthesia was induced with intravenously (IV) administered xylazine (1.1 mg/kg b.w.) and after 5 min., ketamine (2.2 mg/kg. b.w.) was injected intravenously. Horses were positioned in dorsal recumbency on a table. Anesthesia was maintained with 1.5% halothane and oxygen delivered through an orotracheal tube. The ventral aspect of the abdomen was prepared for aseptic surgery.

### *Surgical Procedure*

A 12-cm long, longitudinal, cutaneous incision was created on the ventral midline, and skin on each side of the incision was reflected to expose the musculature of the abdomen. A 4-cm ×8-cm rectangular, full-thickness portion of the abdominal wall, consisting of the aponeurosis of the external abdominal oblique muscle, the rectus abdominis muscle retroperitoneal fat, and peritoneum was removed, citation on an established model for herniation.

### *Treatment Groups*

The abdominal wall defect of horses in group A was repaired with polypropylene mesh (Marlex, Bard Benelux, Nieuwegein, and the Netherlands). The abdominal wall defect of horses in group B was repaired with Sepramesh (Genzyme, Cambridge, MA).

For horses in groups A and B, an 8-cm×12-cm piece of the polypropylene mesh or the Sepramesh was tailored so that at least 2 cm of the mesh overlapped each edge of the defect. The mesh was soaked in normal saline solution, placed intraperitoneally, exposing it to the viscera, and sutured to the cut margins of peritoneum and the apponeurosis of external abdominal oblique muscle contacting in viscera, using a simple-interrupted pattern, with synthetic absorbable sutures, no.2 named polyglycolic acid with a swaged-on, round needle. Sutures were placed 1 cm apart. The fascial edges and muscles were not closed over the prosthesis so that a completely tension-free repair could be performed. Subcutaneous tissues were closed with polyglycolic acid, no.1 in a simple-continuous pattern. The surgical site was then irrigated with warm, sterile normal saline solution combined with an antibiotic. The skin was closed with nylon suture, no.1 using an interlocking pattern. For the horses in group B, the hyaluronic layer of the Sepramesh was placed over the intestine.

#### *Postoperative Care and Observation*

Four to five liters of lactated Ringer's solution was administered during surgery intravenously. After recovery, the horses were allowed water *ad libitum* and were returned to full-feed gradually during the next 24 hours. Horses received procaine penicillin G, 3000000 IU (11000 IU/kg, IM), and trimethoprim-sulphadiazine 48% (2.5 mg/kg trimethoprim and 12.5 mg/kg of sulphadiazine/ kg, IM), daily for 5 days. Each horse was examined daily during first week and then on days 14<sup>th</sup>, 21<sup>st</sup> and 28<sup>th</sup> for signs of pain, incisional swelling or drainage. Blood samples were obtained on days 14<sup>th</sup>, 21<sup>st</sup>, 28<sup>th</sup>. Heart rate, respiratory rate, body temperature and capillary refill time were recorded daily during first week and then on days 14<sup>th</sup>, 21<sup>st</sup> and 28<sup>th</sup>. Horses were assessed for the presence of complications related to the defect, such as herniation, hemorrhage, formation of a hematoma or seroma, and infection. The wound was considered to be infected if it discharged exudates. Hematological values and biochemical profiles were measured every week for 4 weeks (data not shown). On day 14, skin sutures were removed. All horses in both groups were euthanized 28 days after mesh repair and necropsied. The samples that were removed from ventral site of abdomen fixed in 10% neutral buffered formalin. The samples were included health apponeurosis of external abdominal oblique muscle, its sutured site to the meshes and the meshes.

#### *Ultrasonographic Study*

After 28 days, ultrasound examinations of the surgical site were performed to evaluate wound healing and probable complications in all horses in both control and experimental groups.

Ultrasonography was performed by using an ultrasound unit, Sonosite, Micromax (Sonosite, Inc. USA) with 10 MHz linear transducer.

#### *Scoring of Adhesion Severity and Extent*

To investigate the presence of adhesions and other pathological abnormalities, the abdominal incision, peritoneal cavity and abdominal viscera were evaluated according to previously established protocols.<sup>5,6,3</sup> Adhesions between the meshes and viscera were characterized on the basis of their strength and extent by a veterinary histopathologist blinded as which mesh was being evaluated. To evaluate the strength of an adhesion, a scoring system was used (score, 0-3) that reflected the amount of force required to sever the adhesion. In this grading

system, grade 0 represented no adhesion between the prosthesis and the viscera, grade 1 indicated an adhesion that was readily severed, grade 2 indicated an adhesion that could only be severed with traction, and grade 3 indicated the most severe adhesion, one that required sharp dissection to separate the viscus from the prosthesis. To evaluate the extent of adhesions, we used another scoring system (0-4) that reflected the percentage of the abdominal wall that was involved. Areas of abdominal wall covered by prosthesis were divided into quadrants. In this grading system, grade 0 indicated that there were no adhesions between the mesh and the viscera. Grade 1 indicated that one quadrant of that portion of the abdominal wall covered by the prosthesis had some adhesions to the viscera. Grade 2 indicated that between 26% and 50% of the surface area (i.e., two quadrants of that portion of the abdominal wall covered by the prosthesis) had some adhesions. Grade 3 indicated that adhesions covered between 51% and 75% of the surface area (i.e., three quadrants of that portion of the abdominal wall covered by the prosthesis), Grade 4 was attributed to the most severe cases in which adhesions covered more than 76% of the surface area (i.e., all four quadrants of the of that portion of the abdominal wall covered by the prosthesis).

### *Histological Studies*

Samples of mesh and tissue were removed from each horse for histological studies. The tissue samples were fixed in 10% buffered formaldehyde solution (in phosphate-buffered normal saline solution), dehydrated in graded ethanol, and embedded in paraffin (Tissue-Processor, Leica, and Jung Histokinette 2000, Germany). Samples were then cut into 6- $\mu$ m sections (Sliding microtome, Leica, Jung histocuts, Germany) and stained with hematoxylin and eosin (H&E) to assess the structural characteristics. Masson's trichrome staining was used to demonstrate the presence of collagen in tissue sections.<sup>7</sup> The Sections were examined using light microscopy (Olympus, CH36 RF200, Japan) and digitally photographed with a photomicrograph (Olympus DP12, U-TVO.5XC-2, Japan).

The histological changes were quantitatively analyzed by a veterinary pathologist blinded to the treatment. To evaluate the histological changes, such as the severity of hyperemia, edema, necrosis, hemorrhage, rate of synthesis and arrangement of collagen fibers, and the maturation of blood vessels, a semiquantitative grading scale was used. The scoring system used was as follows: zero (0) indicated no change; 1 indicated mild changes; 2 indicated moderate changes; and 3 indicated severe changes (data not shown). To evaluate tissue inflammation, a scoring system from 0-3 was used that modified a previously described method.<sup>3</sup> In this grading system, 0 represented no inflammation (no change), 1 reflected a mild inflammatory reaction with multinucleated giant cells, epithelioid macrophages, scattered lymphocytes and plasma cells, 2 represented a moderate inflammatory reaction with multinucleated giant cells, epithelioid macrophages, increased mixed lymphocytes and plasma cells with polymorphonuclear cells, such as neutrophils and eosinophils, and 3 indicated severe inflammatory reaction with infiltration of mixed inflammatory cells and the formation of microabscesses.

### *Statistical Analysis*

Individual scores for adhesions and inflammation were compared between groups A and B. Significant differences ( $P < 0.05$ ) were determined by the Mann-Whitney U test, which is a simple, nonparametric test that compares the medians of two samples drawn from identical

populations. A P-value of 0.05 or less was the cut-off value that indicated a statistically significant difference between the medians.

## Results

### *Clinical Findings*

With the exception of two horses were in the control group (group A, Horses 1 and 5), there were no other reports of local inflammation, discharge and hyperemia with skin suture loosing postoperatively. The horses that underwent with Sepramesh returned to their usual activities sooner than those that underwent with Polypropylene mesh.

### *Ultrasonographic Observation*

The echogenicity of mesh in nature is hyperechoic and ultrasonographic findings of the surgical sites in group A, horses showed increased echogenicity at the mesh site could be a result of connective tissue formation compared to those in group B. There were also hypoechoic areas in the surgical site and subdermal tissue among the echogenic areas, probably as a result of fluid accumulation due to inflammation (ultrasonographic image from horse 3, which received a polypropylene mesh {A group}, Fig. 1). Actually we guessed the fluid accumulation resulted from inflammatory effusion. Tissue integrity at the surgical site was more regular in the Sepramesh (B) group than control (A) horses. Ultrasonographic examination generally showed that horses in group B had less fluid accumulation around mesh (Fig. 2).



**Figure 1.** Ultraultrasonographic image of a horse from the Polypropylene group 28 days postoperatively; the healing process was heterogenous at the surgical site as a result of excessive fluid accumulation and a probable inflammatory effusion (white arrows) among connective tissue formation. Black arrow shows the mesh site. The horses were in standing position during the ultrasonography procedure and probe



**Figure 2.** Ultraultrasonographic image in a horse from the Sepramesh group; this scan showed a little postoperative complications (white arrow), such as fluid accumulation and inflammatory effusion. Black arrow shows the mesh site. The horses were in standing position during the ultrasonography procedure and probe was linear in transvers plan in mesh site (linea alba).

### Macroscopic Observation

In this study, all horses survived the 28-day experiment. Necropsy of the horses revealed no abnormalities or postsurgical complications with regards to the visceral organs. The prosthesis of all horses was firmly attached to the abdominal musculature and peritoneum. Macroscopically, there was no evidence of infection or impaired wound healing in any of the horses in both groups. The results of the investigations into the strength and extent of the adhesions are presented in Table 1. Most of the horses in group A (polypropylene mesh) had some degree of adhesions between mesh and viscera, but no horses had extensive or tenacious abdominal adhesions. Horses in group A had more adhesions than did horses in group B ( $P<0.05$ ). Sepramesh reduced the degree of the adhesions strength and extent of between the abdominal wall and viscera ( $P<0.05$ ; Fig. 3, Table 1).

**Table 1:** Adhesion strength and extent after the experimental repair of abdominal wall defects with Polypropylene mesh or Sepramesh in horses.

Strength <sup>a</sup>			Extent <sup>b</sup>	
Treatment groups	Individual scores	Group median (range)	Individual scores	Group median (range)
1 Polypropylene (group A)	2, 1, 1, 2, 2	2(1-2)	3, 1, 2, 2, 2	2(1-3)
2 Sepramesh (group B)	0, 1, 0, 1, 0	0(0-1)	0, 1, 0, 2, 0	0(0-2)

<sup>a</sup> Scoring system: 0, no adhesions; 1, adhesions readily divided; 2, adhesions parted with traction; 3, adhesions required sharp dissection to separate.

<sup>b</sup> Scoring system (percentage of abdominal wall involved): 0, no adhesions 1,  $\leq 25\%$ ; 2, 26 to 50%; 3, 51 to 75%; 4,  $\geq 76\%$ .



**Figure 3:** Macroscopic evaluation of the abdominal wall repair in horse no.6 (Sepramesh G); the healthy connective tissue is shown in the upper and middle part of cut edge (top of the scalpel) and no adhesion development was observed.

### Histopathological Findings

The histological examination of sections of the abdominal wall covered by the prosthesis of horses from both groups revealed dense fibrous connective tissue at the wound site that resulted in the adequate formation of scar tissue. In group A, wound healing was further behind that of ones in Group B so wound repair would take longer and resulted in considerable fibrous scarring that contained many active fibroblasts and fibrocyte-type cells, mononuclear and polymorphonuclear inflammatory cells and many foci of granulation tissue. The defect was completely filled with connective tissue that contained thin and relatively parallel collagen fibers. In group B, the defect was filled by collagen fibers bundles dispersed in a plane that was parallel to the longitudinal axis of the abdominal wall with small foci of granulation tissue. Fibroblasts and collagenous fibers were situated mainly in a parallel

manner, and collagen accumulation was much increased when compared with samples from horses in group A. For horses in group B, with the exception of horse 4, the appropriate regeneration of mesothelial cells of the peritoneum had occurred, and neoperitoneal ingrowth of the inner surface of the mesh was almost complete. There was no high degree of adhesion formation by the end of the experiment at 28 days after surgery.

The results of the assessment of inflammation are presented in Table 2. Most of the horses in group A had moderate to severe degrees of inflammation. Most of the horses treated with Sepramesh (group B) had little inflammatory reaction compared to horses in group B, but this was not significant ( $P=0.08$ , Table 2).

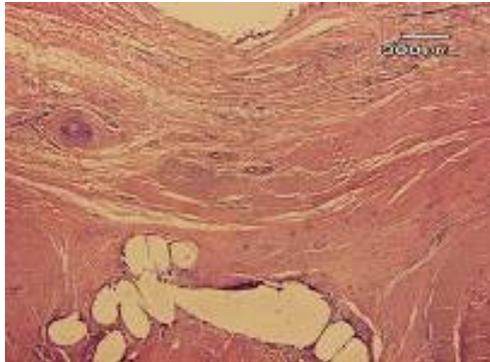
These findings indicated that appropriate wound healing had occurred in horses of group B after the abdominal wall defects were repaired with sepramesh (Figs. 4 and 5, Table 2).

**Table 2:** Inflammation after the experimental repair of abdominal wall defects with Polypropylene mesh or Sepramesh in horses.

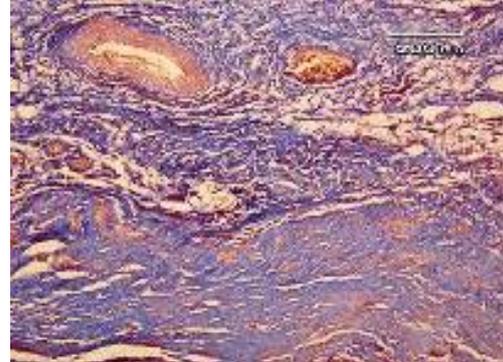
	Treatment groups	Individual	Group median (range)
1	Polypropylene (group A)	3, 2, 2, 3, 3	3(2-3)
2	Sepramesh (group B)	1, 2, 0, 3, 1	1(0-3)

Values for group A were significantly ( $P<0.05$ ) higher than those for group B.

<sup>a</sup> Scoring system: 0, no inflammation; 1, mild inflammation; 2, moderate inflammatory reaction; 3, severe inflammatory reaction with microabscesses.



**Figure 5.** Histopathological evaluation of the abdominal wall repair in horse no.1 (control G); there is irregular healthy connective tissue in the defect and adhesions have appeared in the upper half of this image. H&E, magnification  $\times 40$ .



**Figure 4.** Histopathological evaluation of abdominal wall repair in horse no.2 (experimental G); the regular healthy connective tissue has parallel collagen fibers (parallel to each other and to the abdominal midline) that are blue or violet in color. Masson's trichrome, magnification  $\times 100$ .

## Discussion

Abdominal hernias usually involve protrusion of abdominal viscera through part of the abdominal wall, the diaphragm, or the inguinal canal. The defect, or opening, in the abdominal wall is an important factor in herniation, whether a visceral protrusion through the

opening is presented or not.<sup>8,9</sup> It means an opening in abdominal wall can be dangerous even if any viscus doesn't protrude through it yet. Additionally, the extent of the decrease in laxity of the tissue surrounding the hernia, which is influenced by retraction of muscle and scarification of tissues, may be more important than the actual size of the fascial or hernial defect.<sup>10</sup> Hernial repairs represent one of the most common general surgical operations on human beings, with more than 800,000 inguinal hernias repaired in the US in 2003 and an estimated 90,000 ventral hernias repaired annually.<sup>11,12,13</sup>

Traditional techniques for hernia repair produce tension on the suture line and result in a high incidence of early and late recurrence of the hernia, because an essential surgical principle is transgressed.<sup>14,15</sup> When autogenous tissue is insufficient or inadequate, the repair of abdominal wall defects is performed with metallic or non-metallic meshes.<sup>16</sup> Selection of prosthetic materials is a fundamental step that should consider the risk of infection, a rare complication.<sup>16,17</sup>

Multiple retrospective studies have shown significantly reduced incidence of recurrence of herniation associated with mesh use for Incisional hernia repair (IHR).<sup>18,19,17</sup> Additionally, data from a randomized controlled trial demonstrated that the systematic placement of mesh vs. suture repair during IHR led to a 50% decrease in the incidence of recurrence of the hernia.<sup>19,20,21</sup>

Although most of the prostheses have considerable limitations, and repair of abdominal wall defects with metallic or non-metallic meshes sometimes leads to visceral adhesions, promising results have been reported for physical barriers between the mesh and the viscera.<sup>22,23,24</sup> One of these physical barriers is hyaluronate layer (seprafilm) in sepramesh applied in this study. This experimental study compared two kinds of mesh in a tension-free, mesh-based hernia repair technique in horses: the polypropylene mesh and a coated polypropylene mesh, Sepramesh, which has a protective layer of Seprafilm on its visceral side. This protective layer has composed of polyglycolic acid (PGA) fibers with a bioresorbable, chemically modified sodium hyaluronate (HA), carboxymethylcellulose (CMC) and polyethylene glycol (PEG) based hydrogel. The fascial side of the mesh allows a prompt fibroblastic response through the interstices of the mesh, encouraging complete tissue ingrowth, similar to polypropylene mesh alone. The visceral side of the mesh is a bioresorbable coating, separating the mesh from underlying tissue and organ surfaces to minimize tissue attachment to the mesh. Shortly after placement, the biopolymer coating becomes a hydrated gel that is resorbed from the site in less than 30 days.

Although when placing a mesh in horses, we always try to place the mesh in the retroperitoneal space so as to prevent adhesions from the viscera to the mesh, in this study The polypropylene mesh and Sepramesh were placed intraperitoneally and sutured to the cut margins of peritoneum and the oponeurosis of external abdominal oblique muscle contacting in viscera in a tension-free technique.

Vasoactive substances released after peritoneal trauma increase vascular permeability and exudation of fibrinogen-rich plasma. Injury to tissue stimulates release of tissue thromboplastin and activation of coagulation cascade.<sup>22</sup> As a result, large amounts of activated thrombin convert fibrinogen to fibrin, which in turn, is deposited on peritoneal surfaces.<sup>5,25</sup> Adhesions are the consequence of peritoneal response to injury and inflammation (Aluntas *et al.*, 2000). These adhesions can cause serious complications, such as intestinal obstruction and formation of an enterocutaneous fistula.<sup>14,3,17</sup>

Polypropylene mesh, by inducing an inflammatory response, sets up scaffolding that, in turn, induces the synthesis of collagen.<sup>14,17,10</sup> When the mesh is used intraperitoneally, contact between the polypropylene mesh and the viscera should be avoided because of the risk of adhesions developing between the mesh and the viscera, which in turn, can result in intestinal obstruction or formation of a fistula. Materials, such as Sepramesh, that create a physical barrier between mesh and viscera may be used to protect the viscera and prevent these complications.<sup>22,6,3,24,26</sup>

Sepramesh is made of polypropylene monofilaments and is coated on one side with Seprafilm, a bioresorbable translucent adhesion barrier, composed of two anionic polysaccharides, sodium hyaluronate, and carboxymethylcellulose, which have been shown to be effective in decrease the likelihood of adhesions to surgical incisions when it is used alone or together with polypropylene mesh.<sup>5, 22, 27,23</sup>

The hyaluronate membrane, Seprafilm, serves as a temporary, bioresorbable barrier that separates opposing tissue surfaces. The physical presence of the membrane impedes formation of adhesion tissue while the normal tissue repair process takes place.<sup>3,28,29</sup> These impeding effects also may be due to the biochemical action of hyaluronic acid.<sup>30</sup> Furthermore, it has been shown to reduce the level of adhesions when the mesh is laid over the viscera and fixed to the peritoneum.<sup>3,31,32</sup>

In this study, a negative control group was unnecessary because some tissue adhesion was expected. Group A served as the positive control for the study.

Since after 28 days the bioabsorbable layer of sepramesh change to a jelly form liquid and start to absorb which can prevent adhesion between viscera and mesh in this way, it was preferred ultrasonography was done after 28 days from operation. Ultrasonographic examination of the surgical site was done to evaluate the probably complications which can be diagnose ultrasonographically such as hernia and its contents, fluid accumulation in mesh site. These accumulations usually haematomas or seromas, should not be mistaken for recurrence of the hernia, which can often appear clinically similar, however air may be collects at mesh site due to bacterial infection. We thought ultrasonography could be useful to diagnose these conditions. There are a lot of hypoechoic areas among echogenic areas in ultrasonographic images in both groups can be showed there is no significant difference between two groups but the hypo- and anechoic areas in sepramesh group were more than polypropylene group.

Our findings suggest that, among the two treatment groups, the horses treated with Sepramesh developed less tissue inflammation. Horses that received a polypropylene mesh experienced significantly more inflammation at the surgery site than those that received Sepramesh, both on the day of operation and at 2 weeks postoperatively, but significant differences were not apparent after 4 weeks. This difference was noticeable for inflammation as well, but the results were not significant ( $P=0.08$ ). Additionally, horses that received a polypropylene mesh appeared to experience more pain than those who received Sepramesh, both on the day of operation and at 2 weeks postoperatively.

These findings suggest that the inflammatory response associated with trauma to the underlying viscera caused by the mesh can be overcome by placing an anti-adhesiogenic layer on the side of the polypropylene mesh that faces the viscera. This anti-adhesiogenic layer resulted in a significant reduction in the extent and severity of adhesions between the abdominal viscera and mesh with no evidence that it impaired wound healing in the horses. Selection of the mesh material is important to avoid complications, the most alarming of

which is infection. However, the average incidence of prosthetic infection in human beings is approximately 0.5%<sup>15</sup>. The incidence of recurrence of herniation after traditional hernia repair ranges from 0% to 33% in prosthetic repairs; Therefore, the prosthesis selected should meet 2 criteria: first, it must prevent tension on the suture line, which is the prime cause of recurrence; and second, it must increase the formation of collagen fibers on the transversalis fascia that appears to be histologically and biochemically altered.<sup>15, 21</sup>

The findings establish the superiority of Sepramesh repair over polypropylene alone repair with regards to the tenacity and extent of adhesions and to inflammation. There were significant differences between the groups of horses with regards to the strength and extent of the adhesions ( $P < 0.05$ ). The strength and extent of adhesions were significantly lower in horses in the Sepramesh-repair group (group B) than in horses in the polypropylene-alone?-repair group (group A).

In this study, horses that underwent a tension-free repair with a Sepramesh returned to their usual activities sooner than those that underwent a tension-free repair with a polypropylene alone mesh. In group B, with the exception of horse 4, the regeneration of mesothelial cells of the peritoneum and neoperitoneal ingrowth of the inner surface of the mesh were relatively complete, with no evidence of a high degree of adhesion formation by the end of the experiment at 28 days post-surgery.

The findings reported by Esfandiari and Nowrouzian (2006) indicate that excellent outcomes in hernia repair in mice were achieved with the use of a sandwich technique that placed the peritoneum between the Seprafilm and Sepramesh. This procedure probably reduced and, in some instances prevented, tissue adhesion after the formation of abdominal wall defects. The incidence of complications, such as inflammation and adhesions, were lower in the Sepramesh-repair group than in other groups.<sup>3</sup>

## **Conclusion**

This study confirmed advantages of Sepramesh over polypropylene mesh alone, the current gold standard and most commonly used mesh in the repair of abdominal wall defects in horses. Fewer adhesions and no incidence of intestinal obstruction, enterocutaneous fistula, dehiscence, or recurrence occurred with Sepramesh, and the final healing result was good.

On the basis of our results, we recommend the use of Sepramesh for the repair of abdominal wall defects with as large an overlap as possible. We recommend that the mesh be sutured to the surrounding tissue with intervals of no more than 1 to 2 cm between the sutures. Bulging must be prevented, but the mesh should not be implanted under tension. Additionally, infection did not lead to the removal of mesh in this study, but it was a risk factor for recurrence. Therefore, the administration of broad-spectrum antibiotics at the induction of anesthesia is recommended.

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## ناتیر توری پلی پروپیلن پوشش یافته با غشاء قابل جذب زیستی (سپرامش) در ترمیم نقایص جدار دیواره شکم در اسب

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**هدف-** هدف از انجام این مطالعه مقایسه کاربرد توری جراحی پلی پروپیلن (پرولن) و سپرامش (توری پلی پروپیلن پوشش یافته با غشاء محافظ از سپرافیلیم در سمت احشائی) برای ترمیم نقیصه دیواره شکم در اسب بود. همچنین کیفیت چسبندگی احشایی و التهاب بافتی در محل نقیصه مورد بررسی قرار گرفت.

### طرح مطالعه - مطالعه تجربی

### حیوانات - ده راس اسب

**روش بررسی-** اسب ها به دو گروه کنترل و آزمون تقسیم شدند. نقیصه ای تمام ضخامت به ابعاد  $4 \times 8$  سانتی متر در محل خط میانی شکم ایجاد شد که در گروه کنترل توسط توری پلی پروپیلن و در گروه آزمون توسط توری سپرامش ترمیم شد. هر دو توری جراحی طبق شیوه عاری از کشش و به صورت داخل صفاقی و به لبه بریده صفاق و آپونوروز عضله مورب خارجی شکم به طوری که با احشاء در تماس باشد کارگذاری شدند.

**نتایج-** شدت و گستره چسبندگی به طور معنی داری در گروه آزمون کمتر از گروه کنترل بود ( $P < 0.05$ ). اسب هایی که توسط توری پلی پروپیلن درمان شده بودند سطح بالاتری از التهاب را در روز عمل و دو هفته بعد از آن تجربه کردند. اما این تفاوت بعد از ۴ هفته معنی دار نبود.

**نتیجه گیری و کاربرد بالینی-** موارد بسیار زیادی از نقیصه های دیواره شکم در اسب ها مشاهده شده که می تواند مادر زادی و یا اکتسابی باشند. این مطالعه مزیت و برتری توری سپرامش را به پلی پروپیلن در ترمیم نقایص دیواره شکم در اسب اثبات کرد. این مطالعه پیشنهاد می کند که استفاده از سپرامش می تواند التیام دیواره شکم را تقویت کرده و جلوی فتق برشی و چسبندگی داخل شکمی را بگیرد.

**واژه های کلیدی:** نقیصه دیواره شکم، توری پلی پروپیلن، توری سپرامش، چسبندگی.