A Clinical Grading System for Intraoperative Assessment of Small Intestinal Viability in the Horse

David E. Freeman, MVB, PhD; David J. Schaeffer, PhD; and Gordon J. Baker, BVSc, PhD

Intraoperative use of a new clinical grading system for intestinal viability proved to be accurate in horses with small intestinal strangulation, based on short term and long term outcomes, and obviated small intestinal resection in many horses. Authors' address: University of Illinois, College of Veterinary Medicine, 1008 W. Hazelwood Drive, Urbana, IL 61802. © 2001 AAEP.

1. Introduction

Survival after small intestinal surgery in horses has been reported as poor, although there is growing evidence that more recent survival rates are improving. The most common cause of death during hospitalization in three large retrospective studies were anastomotic leakage, septic peritonitis, and shock. Adhesions accounted for most long-term deaths in two studies and volvulus, adhesions, and malabsorption syndrome accounted for most long-term deaths in another. Adhesions are reported with a prevalence of 6–26% after small intestinal surgery, with an apparent decline in prevalence in more recent reports.

The severity of serosal damage inflicted in remaining bowel by distention and combined ischemia and reperfusion has been incriminated in the development of adhesions in equine small intestine. More severe mural changes caused by venous occlusion, such as hemorrhage and edema, have been demonstrated as a cause of adhesions in horses in an experimental setting. However, experimental design could play a large part in formation of such adhesions, because an association between similar mural changes and adhesions was not demonstrated in another study on ponies. This issue is important in equine small intestinal surgery, because it expands the definition of nonviable bowel to include small intestine that could survive an ischemic insult but subsequently form life-threatening adhesions. A serious concern with this definition is the risk of unnecessary intestinal resection, which is associated with potential problems, including adhesions, expense, and longer surgery time. An overly pessimistic approach to intestinal viability could also lead to euthanasia in horses in which the option of resection is eliminated by prevailing conditions, such as lack of expertise, equipment, financial resources, inaccessibility of the affected segment, or involvement of too much bowel to allow normal intestinal function. This study was designed as a retrospective evaluation of a clinical grading system used to assess intestinal viability in horses that had small intestinal strangulating lesions. Short-term and long-term outcomes were used to assess responses...
and were compared with outcomes after resection and anastomosis techniques.

2. Materials and Methods

Records were examined for horses that recovered or were allowed to recover from anesthesia and surgery for small intestinal lesions at the University of Illinois from May 1994 to March 2001. The duration of colic and the admitting heart rate were obtained from the medical records. A viability score was applied (Table 1; Fig. 1) and a viability index was developed as the product of the viability score and length of bowel involved, in meters. A Fisher’s exact test, or a Kruskal–Wallis test, was used to detect differences between groups and the effects of surgical procedures on short-term survival was analyzed by an ANOVA test for a contingency table. The Kaplan–Meier method was used to estimate long-term survival from the day of surgery and the Tarone–Ware method was used to detect differences at points of strangulation (Fig. 1). Motility weak or induced by snapping a finger against the intestinal wall.

Table 1. Grades of Mucosal Injury Used to Decide on Whether to Resect Strangled Intestine

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Improves within 15 min after correction of the lesion and is similar to healthy adjacent bowel, but slightly darker pink, with mild edema and rare ecchymoses. Motility spontaneous or induced by snapping a finger against the intestinal wall.</td>
</tr>
<tr>
<td>II</td>
<td>Improves within 15 min after correction of the lesion and has marked edema, with extensive ecchymoses, coalescing into diffuse patches of red against a background of dark pink, and no circumferential constrictions at points of strangulation (Fig. 1). Motility weak or induced by snapping a finger against the intestinal wall.</td>
</tr>
<tr>
<td>III</td>
<td>Similar to Grade II, with some circumferential constriction in the wall (Fig. 1) and/or black patches or stripes against a red background.</td>
</tr>
<tr>
<td>IV</td>
<td>Improves slightly or not at all within 15 min after correction of the lesion, and predominantly dark red, blue, or purple, with bowel wall thickness ranging from thin to thick, a flaccid wall, and presence or absence of black striations, a necrotic odor, or constrictions at points of strangulation.</td>
</tr>
<tr>
<td>V</td>
<td>Diffusely gray, black, or green bowel with a necrotic odor.</td>
</tr>
</tbody>
</table>

2. Materials and Methods

Records were examined for horses that recovered or were allowed to recover from anesthesia and surgery for small intestinal lesions at the University of Illinois from May 1994 to March 2001. The duration of colic and the admitting heart rate were obtained from the medical records. A viability score was applied (Table 1; Fig. 1) and a viability index was developed as the product of the viability score and length of bowel involved, in meters. A Fisher’s exact test, or a Kruskal–Wallis test, was used to detect differences between groups and the effects of surgical procedures on short-term survival was analyzed by an ANOVA test for a contingency table. The Kaplan–Meier method was used to estimate long-term survival from the day of surgery and the Tarone–Ware method was used to detect differences at points of strangulation (Fig. 1). Motility weak or induced by snapping a finger against the intestinal wall.

Table 1. Grades of Mucosal Injury Used to Decide on Whether to Resect Strangled Intestine

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Improves within 15 min after correction of the lesion and is similar to healthy adjacent bowel, but slightly darker pink, with mild edema and rare ecchymoses. Motility spontaneous or induced by snapping a finger against the intestinal wall.</td>
</tr>
<tr>
<td>II</td>
<td>Improves within 15 min after correction of the lesion and has marked edema, with extensive ecchymoses, coalescing into diffuse patches of red against a background of dark pink, and no circumferential constrictions at points of strangulation (Fig. 1). Motility weak or induced by snapping a finger against the intestinal wall.</td>
</tr>
<tr>
<td>III</td>
<td>Similar to Grade II, with some circumferential constriction in the wall (Fig. 1) and/or black patches or stripes against a red background.</td>
</tr>
<tr>
<td>IV</td>
<td>Improves slightly or not at all within 15 min after correction of the lesion, and predominantly dark red, blue, or purple, with bowel wall thickness ranging from thin to thick, a flaccid wall, and presence or absence of black striations, a necrotic odor, or constrictions at points of strangulation.</td>
</tr>
<tr>
<td>V</td>
<td>Diffusely gray, black, or green bowel with a necrotic odor.</td>
</tr>
</tbody>
</table>

3. Results

During the period of interest, 88 horses with small intestinal strangulation obstruction were recovered from general anesthesia after surgical correction of their lesions and were evaluated as subjects of this study. Bowel was considered viable and was not resected in 32 horses, 8 with Grade I lesions, 19 with Grade II lesions, and 5 with Grade III lesions (Table 1). Bowel was scored as Grade IV and Grade V in the remainder, and was resected. In all horses in which a resection was not performed, small intestinal contents were manually stripped into the cecum and the cecum was emptied by typhlotomy in three of these horses. In those horses that had a resection, proximal small intestine was decompressed by stripping contents through a transection in the strangulated segment. Jejunocolostomy was performed in handsewn end-to-side (2 horses) or sideto-side fashion (29 horses), and the latter was done with a handsewn technique (13 horses) or with staples (16 horses). With the exception of one horse, the entire staple line was not oversewn. An interrupted Lembert pattern was used in 22 of 25 horses that had a jejunoojjunostomy.

Specific prophylactic measures to prevent adhesions, reperfusion injury, and postoperative ileus (POI) were not used, and endotoxin antiserum was not given to any horse. Postoperative treatment was intravenous balanced polyionic fluids at 1 to 2 L/h/450-kg body weight (bwt) or higher rates and for periods determined by laboratory and clinical assessments. Each horse received potassium penicillin IV at 22,000 U/kg bwt q 6 h and gentamicin at 6.6 mg/kg bwt IV q 24 h or at 2 mg/kg IV q 6 h for 3 days. Flunixin meglumine was given at 1.1 mg/kg bwt IV once or twice daily for 2–3 days after surgery, or as needed. An indwelling nasogastric tube was placed after surgery in 4/88 (4.5%) horses and a tube was passed only as needed in the remainder if horses developed POI. Horses without tubes, or that did not have postoperative pain or reflux, were allowed water at 12–18 h and were fed a small handful of alfalfa hay at 18–24 h after surgery. If this amount of hay was well tolerated and the horse was comfortable, intake was increased slowly.

Of the 88 horses that recovered from general anesthesia, 75 were discharged from the hospital (85%). Short-term survival for end-to-end anastomosis (92%; 23/25) and for no resection (94%; 30/32) were superior (p < 0.05) to survival for jejunocecal anastomosis (77%; 24/31). Of the two horses that died during hospitalization after no resection, one had a Grade I lesion and died from postoperative ileus, and the other had a Grade I lesion and was euthanatized because of colic from adhesions.

Long-term follow-up information was available on 68 horses, with survival of 50/68 (74%). After discharge from the hospital, 6 horses died or were euthanized for non-gastrointestinal problems and old age, 3 deaths were from colic of unknown cause, 2 were from adhesions, 1 from small intestinal volvulus, 1 from cecal lymphosarcoma and 1 from malabsorption/maldigestion. One horse that had a Grade II lesion left in place required a second surgery 2 weeks later because of adhesions. According to the Kaplan–Meier survival estimates, the sharpest decline in survival was in the first postoperative week,
with slower decline after that (Fig. 2). In horses that had a strangulating lesion, survival was better if resection was not required than if a jejunojejunostomy or jejunocæcostomy was done, but this difference was not significant (Fig. 2). Survival for jejunojejunostomy and jejunocæcostomy became similar with time after discharge (Fig. 2).

4. Discussion

Results of this study demonstrated that prognosis for surgery of the equine small intestine is better than reported in earlier studies. A shorter mean duration of colic than that reported before 1980, when survival rates were lower, could explain this difference. Also, because horses that do not need resection have shorter mean duration of colic than those that do need resection, the importance of early referral is further emphasized. Most postoperative fatalities in this study were in the immediate postoperative period and 12 months appeared to be critical, because there was little if any change in survival after that (Fig. 2).

In this study, we used a clinical grading system that appeared to be useful for identifying intestinal

Fig. 1. A. Grade II changes in a horse that had a strangulation by a lipoma. B. Close view of transition from strangulated to healthy bowel, with a constriction, consistent with a Grade III lesion.
changes that do not require resection (Table 1; Fig. 1). The favorable outcome in these horses could be attributed to the shorter segments involved and milder lesions compared with horses that underwent resection.4 Although results of studies on experimentally induced small intestinal strangulation would suggest that such lesions would be prone to adhesion formation,7 this has not been a consistent finding.5 Application of a more optimistic approach to segments that we scored as Grades I, II, and III (Table 1, Fig. 1) eliminated the need for resection in many horses. We did not treat these horses for reperfusion injuries; however, one horse did develop adhesions and another had POI after Grade I lesions were left in place. Both horses had prolonged surgeries, with extensive intestinal handling, and the management of both differed from others in that distended bowel was inadequately decompressed at surgery. Adhesions that required a second surgery developed in a horse with a Grade II lesion, but this bowel had some bluish discoloration that would be consistent with a Grade IV rating. This underscores the subjective nature of the grading system and the possibility that errors could arise from misinterpretation of findings.

Based on our results with Grade I to Grade III changes, we conclude that the risk of adhesions might not be any greater if these segments are left in place than after resection and anastomosis. However, improved methods of adhesion prevention, such as carboxymethylcellulose and hyaluronate membrane on the suture line, could reduce the risk of anastomotic adhesions considerably.11 Nonetheless, the short duration of surgery without resection, the decrease in expense and the relative lack of complications would make this a more acceptable approach than jejunocoeostomy, if this were the only other alternative for treatment. It would also eliminate a resection in horses that would be at risk for malabsorption if a large amount were resected or euthanasia if affected bowel were inaccessible.5

Our prevalence of confirmed adhesions was 5%, although the true prevalence was difficult to determine because most deaths from colic after discharge did not have a necropsy. Inclusion of deaths from colic yielded an estimated prevalence of 13%, which is similar to, or better than that reported in most studies1–2 on small intestinal surgery; although higher than the 6% reported in one.3 Complications from adhesions were more likely in the first 3 weeks after surgery and deaths from colic and adhesions became less likely with time (Fig. 2). Although we were not able to establish the role of adhesions in all postoperative deaths, we gained the impression that adhesions were more likely with end-to-end anastomosis than with no resection or jejunocoeostomy (Fig. 2). Adhesions were confirmed in 6% of horses that did not have a resection, which would suggest that at least they were at no greater risk than if the bowel were resected. The difference in adhesion prevalence between the end-to-end anastomosis and jejunocoeostomy could be explained by the greater potential for intestinal distortion by adhesions to the more mobile end-to-end anastomosis.

Although several methods have been used to assess intestinal viability,12 they do require special equipment and familiarity with use. Some of the required equipment is readily available and inexpensive, such as fluorescein fluorescence, but some is not. These techniques also have a subjective component to them that could be as difficult to resolve as the clinical method we have described.13 Also, some techniques are less effective with certain pathologic changes than others, such as fluorescein in the presence of hemorrhage, and this narrows their ranges of usefulness.13 The most important criterion in our system is color assessment, combined with other physical changes and an overall assessment of improvement with correction of the lesion. Most surgeons are familiar with the color changes in strangulated intestine. The basic premise of our technique is that changes consistent with early venous strangulation obstruction are consistent with a correct viability score. Such changes are red discoloration and even some black patchiness or stripes in bowel with a thick and edematous wall. Blush discoloration suggests arterial occlusion6 and a poorer prognosis for survival, especially if the affected area of bowel wall is thin. The changes in a Grade IV or V lesion are strong evidence of necrosis and indicative of poor viability. Grade III lesions would appear to be severe enough to make this category marginal and subject to difficulty in interpretation in some cases.

The proposed grading system should be of tremendous value to the equine practitioner that might be confronted with a horse with small intestinal evisceration after castration or abdominal accident, if financial constraints eliminate referral and more
aggressive treatment. In our series of cases, four horses had eviscerations that induced Grades II (2 horses) and III (2 horses) strangulating lesions. All 4 responded favorably to copious lavage and closure of the wound after bowel replacement (castration incision and ventral median celiotomy, 2 each). Intestinal resection was not an option in these cases because of expense and the amount of bowel involved (>80% of small intestine in a foal). All four horses had excellent short and long term outcomes with follow-up periods of 2 to 4 years.

Although improved survival from colic surgery should be regarded as the natural result of progress in all aspects of colic management, early referral is probably one of the most important determinants of outcome. The importance of early referral is underscored by the high survival in horses that did not need a resection, which was the group with the shortest duration of colic and the lowest grade of intestinal injury. Our finding that risk of death from surgery-related problems diminished with time after surgery is encouraging. We believe that our viability scoring system should be useful in management of future cases and is simple to apply, despite the subjective nature of the technique.

References