Evaluation of Intraoperative Culture Results as a Predictor for Short-Term Incisional Complications in 49 Horses Undergoing Abdominal Surgery

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This study evaluated bacterial isolates obtained during abdominal surgery and their relationship to short-term incisional complications. Samples of peritoneal fluid and from resection and/or enterotomy sites from 49 horses were cultured, with 96% having at least one positive culture result. The most common isolates were Escherichia coli, Streptococcus spp, and Enterococcus spp. Horses with small intestinal resections were more likely to grow obligate anaerobes and enteric organisms. Horses with small intestinal lesions (± resection) were more likely to grow enteric organisms and less likely to grow non-enteric organisms. Horses without enterotomy or resection procedures were more likely to grow <3 isolates and did not grow obligate anaerobes. The continued incisional drainage rate was 10%. Horses with preoperative peripheral leukocyte counts >8,500 cells/µl were more likely to develop incisional drainage. Many horses undergoing abdominal surgery may have positive intraoperative culture results. Our results did not provide evidence for the routine use of intraoperative culture to predict short-term incisional complications. Further studies are needed to evaluate the value of intraoperative culture in horses at high risk for incisional complications.

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The relationship between the presence of resistant intraoperative isolates and the incidence of postoperative infections has also been evaluated in various human gastrointestinal (GI) procedures, with some studies finding a correlation between resistant isolates and postoperative complications\textsuperscript{16–18} and others finding no correlation or limited value in intraoperative culture results.\textsuperscript{19–22}

To our knowledge, there has not been a study that describes intraoperative isolates during equine abdominal surgery that evaluates the potential relationship between intraoperative isolates and incisional complications. Based on findings in human colorectal surgery, this study evaluated the potential for equine intraabdominal isolates to contribute to incisional infections.

The purpose of this study was to identify the intraoperative bacterial isolates obtained during equine abdominal surgery and evaluate their relationship to short-term incisional complications. The study hypothesis was four-fold: (1) positive intraoperative bacterial cultures during abdominal surgery can predict the development of postoperative short-term incisional complications; (2) a positive correlation exists between postoperative incisional complications and the number of different bacterial species isolated from peritoneal fluid and enterotomy sites during abdominal surgery; (3) postoperative incisional complications after abdominal surgery are more likely in horses from which enteric bacteria are cultured from the peritoneal fluid and enterotomy sites than in those from which other, non-enteric bacteria are isolated; and (4) postoperative incisional complications after ab-

**Despite improvements in surgical technique and outcome, incisional complications remain a common and difficult postoperative problem in horses.**
Abdominal surgery are more likely when bacteria that are resistant to preoperative antimicrobial therapy are isolated from the intraoperative cultures.

**MATERIALS AND METHODS**

**Horses**

A prospective study of 49 horses undergoing abdominal surgery for colic from December 1999 to January 2001 was performed. Horses that qualified for the study met the following requirements: exploratory celiotomy through a ventral midline incision, linea alba closure with #2 polydioxanone (Ethicon), and no previous abdominal surgery. Exclusion criteria for the study were repeat laparotomy, presence of intraabdominal infection at the time of operation, oral antimicrobial administration within 2 weeks of study enrollment, or death of the patient during the hospitalization period. Three primary surgeons and four residents participated in the celiotomies.

**Pre- and Intraoperative Data**

Demographic data such as age, sex, breed, and weight were recorded for each horse. A standard emergency examination for colic was performed on all horses. Preoperative data recorded for the study included heart rate, peripheral leukocyte count and serum total protein, and peritoneal fluid leukocyte count and total protein. Intraoperative data recorded for the study included the surgical lesion, location, procedure, and duration. Other health data were obtained when possible but were not statistically evaluated because the primary purpose of the study was to evaluate the results of intraoperative culture results relative to short-term incisional complications and the region of the intestinal tract involved.

**Standard Intraoperative Procedures**

All horses were administered potassium penicillin (22,000 IU/kg IV), gentamicin (6.6 mg/kg IV), and flunixin meglumine (1.1 mg/kg IV) preoperatively. Surgeries were performed by making a routine ventral midline incision into the peritoneal cavity through the linea alba. A ring drape (Steri-Drape, 3M) was placed through the incision, and the lesions were located and corrected. At the end of the surgical procedure, the abdominal cavity was copiously irrigated first with sterile isotonic saline and then with 2 L of saline supplemented with 22,000 IU/kg potassium penicillin, 2.2 mg/kg gentamicin, and 40 IU/kg heparin. The linea alba was closed in an inverted cruciate pattern using #2 polydioxanone (Ethicon). A portion of the saline–antimicrobial irrigation solution was poured over the linea prior, and then the subcutaneous layer was closed in a simple continuous pattern with either 2-0 polydioxanone or 2-0 polyglactin 910. The skin was closed with stainless steel staples. The use of a stent was based on surgeon preference.

**Peritoneal Fluid and Site Culture Technique**

Before abdominal lavage was performed during surgery, peritoneal fluid was collected, as were samples from every enterotomy, resection, and anastomosis site. Aerobic and anaerobic cultures were performed on all samples using standard culture swabs with modified Stuart medium and anaerobic transport medium (BactiSwab, A.C.T., Remel, Lenexa, KS). Abdominal fluid (10 ml) was also placed into a trypticase soy broth blood culture system with resins (TSBR) (BBL Septi-Chek TSB/Resins, Becton, Dickinson and Company) to optimize bacterial recovery with antimicrobial use. Aerobic and anaerobic isolates were identified by standard methods. Aerobic susceptibility testing was carried out using standard microbroth dilution techniques with the Trek-Sensititre System (Trek Diagnostics, Cleveland, OH).
All bacterial isolations, identifications, and antimicrobial susceptibility tests were performed at the Veterinary Medical Diagnostic Laboratory of the University of Missouri-Columbia College of Veterinary Medicine.

**Site Culture and Isolates**

Site culture and isolate variables were identified and categorized as described in Table 1.

**Incision Evaluation**

Horses were hospitalized for a minimum of 10 days, and the preoperative antimicrobial regimen continued based on the senior clinician’s (J. K., D. A. W., or K. G. K.) evaluation of each case. A standardized system was used to evaluate the incision on a daily basis while the horses were hospitalized. The incisions were monitored for drainage, drainage character, edema, pain on palpation, and dehiscence of skin and/or subcutaneous tissue; scores and characterizations were assigned as described in Table 2. Scores were assigned for each incisional complication on each day a horse was hospitalized, and the scores were averaged for each complication over the hospitalization period. Horses with drainage lasting longer than 12 hours after surgery or occurring more than once while hospitalized were categorized as having “continued drainage.” Abdominal bandages were not used. Incisions with continued drainage were cleaned daily as needed using sterile gloves and povidone–iodine scrub solution. For statistical analysis, short-term incisional complications were defined as edema, pain, superficial dehiscence, one occurrence of drainage within no more than 12 hours after surgery, or drainage more than once during the hospitalization period (“continued drainage”).

**Statistical Analysis**

The effect of individual variables on the oc-
currence of individual incisional complications or abdominal culture results was examined. Initially, a $\chi^2$ test was used to evaluate categoric variables. A Fisher exact test was performed if a cell in the statistical $2 \times 2$ contingency table had an expected frequency <5. Odds ratios (ORs) and 95% CIs were calculated for individual variables to determine the magnitude of their association with incisional complications and abdominal culture results. For all analyses, $P < .05$ was considered significant.

Forward stepwise logistic regression analysis was used to identify associations between independent variables and short-term incisional complications. Short-term incisional complications were defined as described in the Incision Evaluation section, above. Independent variables considered were demographic data, pre- and intraoperative data, and abdominal culture results.

Forward stepwise logistic regression analysis was used to identify associations between independent variables and abdominal culture results. Abdominal culture results are described in the Site Culture and Isolates section, below. Independent variables considered were demographic data and pre- and intraoperative data.

Complete data for all variables were available for 43 of 49 horses. For all regression analyses, records with incomplete data for any of the considered variables were excluded. At each step of the forward stepwise regression analysis, the variable with the smallest $P$ value was permitted to enter the model. The process was repeated until all variables with values of $P < .05$ were included in the model.

**RESULTS**

**Demographic Data**

Forty-nine horses undergoing exploratory celiotomy were included in the study. There were 21 mares, 20 geldings, and 8 stallions. Age of horses ranged from 4 months to 30 years (mean age, 10 years). Breeds included American Quarter horse ($n = 16$), American Saddlebred ($n = 5$), Arabian ($n = 5$), draft horse ($n = 2$), Missouri fox trotter ($n = 2$), paint ($n = 6$), pony breed ($n = 3$), Thoroughbred ($n = 4$), and other ($n = 6$).

**Preoperative Data**

The mean maximum preoperative heart rate was 62 ± 19 bpm. The mean peripheral leukocyte count was 9,806 ± 5,489 cells/µl (refer-

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<table>
<thead>
<tr>
<th>TABLE 2. Daily Scoring Method for Incisional Complications</th>
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<tbody>
<tr>
<td><strong>Parameter</strong></td>
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<td>----------------</td>
</tr>
<tr>
<td>Incisional drainage</td>
</tr>
<tr>
<td>Drainage character</td>
</tr>
<tr>
<td>Edema</td>
</tr>
<tr>
<td>Pain on palpation</td>
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<tr>
<td>Dehiscence</td>
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</table>
Primary Lesion and Procedures Performed in 49 Horses Undergoing Abdominal Surgery

Small intestinal lesions ($n = 26$)
- SI resection: 16 (62%)
  - Jejunojejunostomy: 10 (38%)
  - Jejunoc Cecostomy: 6 (23%)
- No SI resection: 10 (35%)
  - Pelvic flexure enterotomy: 1 (4%)

Cecal lesions ($n = 3$)
- Typhlectomy: 1 (33%)
- Typhlectomy + right ventral colon enterotomy + pelvic flexure enterotomy: 1 (33%)
- Typhlectomy + pelvic flexure enterotomy: 1 (33%)

Large intestinal lesions ($n = 16$)
- Enterotomy: 14 (88%)
- No enterotomy: 2 (12%)

Small colon lesions ($n = 4$)
- Pelvic flexure enterotomy: 2 (50%)
- No enterotomy: 2 (50%)

The LI lesions were volvulus ($n = 7$), displacement ($n = 5$), and impaction ($n = 4$). All SC lesions were impactions ($n = 4$). The box on this page lists the surgical findings, the lesion location, and procedure performed during surgery. The mean surgical time was $149 \pm 61$ minutes.

Site Culture and Isolates
Forty-seven of 49 horses (96%) had positive cultures on at least one sample. A variety of bacterial isolates were grown from the peritoneal fluid and site cultures (Table 3), with *Escherichia coli* (28%), *Streptococcus* spp (17.7% [91% of which were α-hemolytic streptococci]), and *Enterococcus* spp (13.6%) being the three bacteria most frequently isolated. TSBR yielded the greatest number of isolates per culture, with peritoneal fluid cultures from 47 of 49 (96%) horses yielding growth; there was no growth on any peritoneal fluid culture for the other two horses. Swab cultures of the peritoneal fluid yielded growth in 25 of 49 (51%) horses.

Susceptibility
Of the 47 horses with positive cultures, 41 (87%) had aerobic isolates that were susceptible to the pre- and postoperative antimicrobial therapy. Mean duration of antimicrobial therapy was $5.8 \pm 4.3$ days for all horses, $4.5 \pm 2.5$ days in the 13 horses in which no resection or enterotomy was performed, $4.6 \pm 1.4$ days in LI and/or C horses, $8.4 \pm 6.4$ days in SI horses, and $6.4 \pm 1.2$ days in horses with continued incisional drainage.

Short-Term Incisional Complications
According to logistic regression analysis, only sex (geldings and/or stallions), peripheral leukocyte count (>8,500 cells/μl), and the presence of non-enteric bacteria were significantly associated with one or more short-term incisional complications.
Incisional Edema

The mean edema score was 1.49 ± 0.44. According to univariate analysis, geldings and stallions were more likely than mares to have an edema score ≥1.5 (P = .003; OR, 5.36; 95% CI, 1.37%–21.64%).

Incisional Drainage

Twenty-two horses (45%) had incisional drainage. Seventeen (35%) had drainage at only one point during the hospitalization period (within 12 hours after surgery) and five (10%) had continued drainage (drainage more than once during the hospitalization period). The mean incisional drainage score was 0.17 ± 0.25, and the mean drainage character score was 0.18 ± 0.32.

Exudate was cultured from two of the five horses that developed continued incisional drainage. Culture of one of the incisions isolated an E. coli that was similar to an intraoperative isolate and was resistant to perioperative antimicrobial therapy. The other incisional culture isolated Staphylococcus epidermidis, which was not similar to an intraoperative isolate and was also resistant to periop-
erative antimicrobial therapy.

According to univariate analysis, variables significantly associated with continued drainage were a preoperative leukocyte count >8,500 cells/µl (P < .001; OR, ∞) and a dehiscence score ≥1 (P = .007; OR, ∞).

Incisional Pain

The mean incisional pain level score was 1.12 ± 0.20. According to univariate analysis, horses with an incisional edema score ≥1.5 were more likely to have incisional pain ≥1 (P = .005; OR, 4.85; 95% CI 1.29%–18.15%). Horses with non-enteric isolates were more likely to have pain scores >1 (P = .002; OR, 5.67; 95% CI, 1.21%–35.25%).

Procedure and Abdominal Culture Results

According to logistic regression, abdominal culture results were significantly different for horses with no resection or enterotomy, horses with SI lesions (regardless of whether they required resection), and horses with SI resection. According to univariate analysis, horses with SI resection were more likely to grow obligate anaerobes (P ≤ .001; OR, 12.86; 95% CI, 2.75%–60.22%) and ≥2 enteric bacteria (P = .003; OR, 13.54; 95% CI, 3.06%–59.88%) compared with horses with LI and/or C enterotomy and compared with horses without resection. Horses with SI lesions (regardless of whether resection was required) were also more likely to grow ≥2 enteric bacteria (P = .003; OR, 5.44; 95% CI, 1.52%–19.41%) and more likely to grow zero non-enteric bacteria (P = .012; OR, 10.67; 95% CI, 2.51%–45.39%) than horses without an SI lesion. Horses without enterotomy or resection procedures were more likely to grow <3 isolates (P < .001; OR, 0.05; 95% CI, 0.01%–0.24%) and did not grow any obligate anaerobes (P = .036; OR, 0). Table 4 lists the correlation of intraabdominal culture results with lesion location and procedure performed.

### TABLE 4. Correlation of Intraabdominal Culture Results With Lesion Location and Procedure Performed

<table>
<thead>
<tr>
<th>Procedure Performed</th>
<th>Lesion Location</th>
<th>Culture Variables*</th>
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<tbody>
<tr>
<td></td>
<td>SI (26 horses)</td>
<td>Non-SI (23 horses)</td>
</tr>
<tr>
<td></td>
<td>SI Resection (16 horses)</td>
<td>Enterotomy (20 horses)</td>
</tr>
<tr>
<td>≥3 Isolates</td>
<td>18 (69%)</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>≥2 Enteric bacteria</td>
<td>16 (62%)†</td>
<td>5 (22%)</td>
</tr>
<tr>
<td>0 Non-enteric bacteria</td>
<td>16 (62%)†</td>
<td>3 (13%)</td>
</tr>
<tr>
<td>≥3 Gram-negative bacteria</td>
<td>7 (27%)</td>
<td>2 (9%)</td>
</tr>
<tr>
<td>≥3 Gram-positive bacteria</td>
<td>2 (8%)</td>
<td>3 (13%)</td>
</tr>
<tr>
<td>≥1 Aerobic bacteria</td>
<td>3 (12%)</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>≥3 Anaerobic bacteria</td>
<td>17 (65%)</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>≥3 Facultative anaerobic bacteria</td>
<td>15 (58%)</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>≥1 Obligate anaerobes</td>
<td>9 (35%)</td>
<td>3 (13%)</td>
</tr>
</tbody>
</table>

*Variables characterized as 1 as defined in Table 1, except for the entry for “0 non-enteric bacteria.”
†Values within the row for lesion location or for procedure performed are significantly different (P < .05).
C = cecum; LI = large intestine; SI = small intestine
DISCUSSION

This is the first study in horses, to our knowledge, to examine the relationship between intraabdominal culture results and incisional complications. The results of this study did not support our hypotheses. Positive intraoperative bacterial cultures did not predict short-term incisional complications (hypothesis 1). Overall, 47 of 49 horses had a positive culture result. Although enterotomy and resection site cultures were expected to be positive, as were peritoneal fluid cultures from horses in which resection or enterotomy was performed, we were surprised at the number of positive peritoneal fluid cultures (11 of 13) from horses not undergoing enterotomy or resection. The high number of positive peritoneal fluid cultures in horses not undergoing enterotomy or resection may have been related to leakage from inflamed and or severely distended intestinal wall. Survey culture results of the peritoneal fluid in equine abdominal surgery have not been previously reported. Ingle-Fehr and associates\textsuperscript{5} cultured the linea alba before closure and had an overall positive culture rate of 44%.

The use of the TSBR culture system in addition to swab cultures in our horses may have increased the likelihood of obtaining a positive peritoneal fluid culture by increasing the number of submissions per horse; also, TSBR may be more sensitive than swab cultures.\textsuperscript{25,26} In our study, 47 of 49 TSBR peritoneal fluid cultures were positive whereas only 25 of 49 swab peritoneal fluid cultures were positive. The increased number of positive cultures with the use of TSBR versus swab culture may be related to both the increased sensitivity of TSBR and the increased sample volume (10 ml) required for TSBR.

Systemic and local host defenses play an essential role in the prevention of infection. Previous studies have suggested that in most cases the immune system is able to suppress contaminating bacteria if their concentration is \(<10^5\) per gram of tissue or milliliter of fluid.\textsuperscript{27,28} The lack of correlation between abdominal culture results and incisional infection in our study may be related to a low concentration of bacteria in the tissues and an effective host immune response.

Another possibility for the lack of correlation between abdominal culture results and incisional infection may have to do with the small number of horses with continued incisional drainage in our study. A larger sample size would have increased the likelihood of detecting a difference between horses with and without incisional drainage.

The results of human studies are mixed, with some researchers advocating intraoperative culture and others suggesting that it has limited value.\textsuperscript{16–20,22} In our study, positive intraabdominal culture results were common but were not correlated with such short-term incisional complications as drainage or dehiscence. Although the value of intraabdominal culture in humans with limited peritoneal contamination and minimal premorbid conditions is debated, clear recommendations have been made for intraoperative culture in patients who have multiple medical problems, present for treatment after significant delay, are acutely physically debilitated, are receiving immunosuppressive medications, or have altered GI flora.

Positive intraoperative bacterial cultures did not predict short-term incisional complications.
because of recent hospitalization or treatment with antimicrobials. Similarly, the true value of intraabdominal culture results in equine surgery may not be evident until studies with a larger subset of horses with severe compromise or conditions that alter gut flora are conducted. To have uniform risk factors among our study population, we excluded horses with repeat celiotomy or previous antimicrobial therapy, but the value of intraabdominal culture may be greater in such horses.

_E. coli_, _Streptococcus_ spp, and _Enterococcus_ spp were the most frequently isolated bacteria and were isolated in 28%, 17.7%, and 13.6% of cultures, respectively. This compares to the intraoperative incisional culture results reported by Ingle-Fehr and associates: 28% of the positive cultures isolated _E. coli_ and 41% isolated _Streptococcus_ spp, but zero _Enterococcus_ spp were isolated.

_E. coli_ and _Streptococcus_ spp have also been reported frequently in operative site cultures obtained during human colorectal surgery. _Enterococcus_ spp have been isolated from postoperative abdominal abscesses and incisional infections. _E. coli_ and _Enterococcus_ spp are facultative anaerobes and considered to be a normal part of the intestinal flora. We considered the source of _E. coli_ and _Enterococcus_ spp in our cultures to be GI flora.

Although not a predominant part of normal GI flora, _Streptococcus_ spp have been isolated from the equine cecum but are more commonly isolated from the respiratory tract. Others have considered the presence of _Streptococcus_ to be from environmental contamination. The source of _Streptococcus_ spp in our study was unknown; however, because more than half of the _Streptococcus_ isolates in our study were from site cultures, it may be that the primary source of _Streptococcus_ spp in our horses was GI flora.

Obligate anaerobes were isolated in 9% of cultures. Species included _Clostridium_, _Bacteroides_, and _Propionibacterium_. Obligate anaerobes comprise 99% of the intestinal flora. _Bacteroides fragilis_ is a reported pathogen in human and equine peritonitis. The importance of synergistic combinations of anaerobic and aerobic bacteria that are pathogenic has also been emphasized.

Most (69%) species isolated from our cultures were considered enteric. Other isolated species (e.g., _Streptococcus_) may have originated from the GI tract but cannot with certainty be considered enteric. This suggests that the most common origin of peritoneal fluid bacteria was from opening the GI tract during the surgical procedure or from leakage of the bacteria through an inflamed or compromised gut wall.

A correlation was not found between the number of different bacterial species isolated from intraoperative samples and the development of short-term incisional complications (hypothesis 2). This is in contrast to the study by Grant and colleagues of humans who underwent elective colorectal surgery, in which patients with infectious complications were more likely to have ≥3 bacterial isolates from peritoneal irrigation fluid and >4 bacterial isolates from anastomosis sites.

Despite the large percentage of enteric bacteria isolated, short-term incisional complications were not more likely to develop in horses in which enteric bacteria were isolated in our study (hypothesis 3). In contrast, the only correlation detected between intraoperative isolates and incisional complications was an association between the culture of non-enteric bacteria and the development of incisional pain. The reason for this correlation is not clear but may be related to each bacterial species’ ability to incite an inflammatory response. Additionally, many of the horses that grew non-enteric bacteria had large intestinal disorders that required exteriorization of the
large colon and thus the incision may have been subjected to more stretching and trauma. Incisional complications were not more likely when bacteria isolated from intraoperative cultures were resistant to preoperative antimicrobial therapy (hypothesis 4). The lack of correlation between antimicrobial resistance of intraabdominal isolates and short-term incisional complications in our study is consistent with results of some human studies that did not find a correlation\textsuperscript{19,20,22} but may also be influenced by the low number of cases with antimicrobial resistance. Of the 47 horses with positive cultures, 41 (87\%) yielded bacterial isolates that were susceptible to the perioperative antimicrobial therapy. In all equine patients, perioperative antimicrobials consisted of potassium penicillin and gentamicin. Despite the widespread use of penicillin–gentamicin combinations in this clinic, most intraoperative isolates obtained during abdominal surgery were susceptible to this regimen. Had perioperative antimicrobial therapy not been administered, the correlation between culture results and short-term incisional complications may have been different. Additionally, as bacteria become increasingly resistant, monitoring intraoperative resistance patterns may be important in the development of future antimicrobial prophylaxis recommendations for equine abdominal surgery.

Incisional drainage is generally considered indicative of incisional infection.\textsuperscript{4} A limitation of our study is the culture results from 2 of 5 horses with incisional drainage. Both of the cultured incisions grew isolates resistant to perioperative antimicrobial therapy, but only one of the incisions grew an isolate similar to an intraoperative isolate. Ingle-Fehr and associates\textsuperscript{5} cultured 5 of 16 horses with incisional drainage, and only 1 of the 5 horses cultured had the same bacterial species isolated from the incision as from the intraoperative incisional culture. Obtaining a true culture of incisional drainage is difficult when the drainage is intermittent or there is scant exudate to obtain a sample for culture. However, additional culture results from the incisional drainage of horses and correlation of the results with intraoperative isolates would have provided useful information. Additional studies evaluating the bacterial isolates in large numbers of horses with established ventral midline infections would also be valuable.

We did not obtain long-term follow-up on these horses. Although many incisional complications could be expected to develop within our follow-up period (at least 10 days), lack of long-term (at least 2 months) follow-up prevented us from detecting longer-term complications such as hernia formation. It is also possible that incisional drainage may have developed after the follow-up period. Thus the occurrence of incisional complications may be underestimated in this study.

In humans, remote trauma (i.e., trauma to a region other than where surgery is being performed) and distant infections (i.e., infection at a site other than where surgery is being performed) are often listed as risk factors for incisional complications. A correlation was not found between the number of different bacterial species isolated from intraoperative samples and the development of short-term incisional complications.
formed) have been reported to increase the surgical-site infection rate. In our study, horses with preoperative systemic leukocyte counts >8,500 cells/µl were more likely to have incisional drainage. Horses with increased leukocytes may have had another site of infection or have been in a proinflammatory state and more likely to develop an incisional infection, but we did not find additional clinical evidence to support this.

The role of other factors associated with surgery, such as edema in incisional infections, is not clear and likely depends on the underlying cause. Edema can be a result of decreased venous or lymphatic return, increased hydrostatic pressure, or decreased oncotic pressure or can be associated with increased vascular permeability secondary to an inflammatory response. Edema can contribute to bacterial invasion by increasing tension across the incision, which disrupts blood supply to the wound margins and increases the likelihood of superficial dehiscence and subsequent bacterial invasion, or it can develop secondary to the inflammatory response evoked by bacteria already present in the intercellular space. Coomer et al found that incisional edema was associated with a higher risk of wound suppuration, and Gibson and coworkers found an association between edema and abnormal healing. Our study did not find an association between postoperative edema and incisional drainage.

In this study, the incisional edema score for geldings and stallions was significantly greater than for mares. A possible explanation is urine or sheath contamination of the incision during the recovery or early postoperative period inciting an inflammatory response. Horses with edema were also more likely to experience pain on incisional palpation. This pain could be secondary to increased tension across the incision or to inflammation associated with the edema.

**CONCLUSION**

Incisional infections are a complex, multifactorial problem. In our study, intraoperative culture results did not correlate with short-term incisional complications. Despite standard aseptic surgical protocol, most horses had positive intraoperative cultures. This points to the significant role of both systemic and local host immunity in the prevention of ventral midline incisional infection. In addition to the studies identifying clinical predictors and surgical factors related to incisional complications, studies aimed at evaluating the host immune response may be beneficial in determining methods to decrease the rate of incisional infections.

**REFERENCES**


