Comparison of surgical site infection rates in clean and clean-contaminated wounds in dogs and cats after minimally invasive versus open surgery: 179 cases (2007–2008)

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Objective—To report and compare the surgical site infection (SSI) rates for clean and clean-contaminated procedures performed by either a minimally invasive surgical or open surgical approach in a large population of dogs and cats.

Design—Prospective case series.

Animals—179 patients (dogs and cats) undergoing minimally invasive abdominal or thoracic surgery.

Procedures—Case information from all animals that underwent minimally invasive abdominal or thoracic surgery was prospectively collected and compared with an existing database of the same information collected from 379 patients undergoing laparotomy or thoracotomy via an open surgical approach. For both groups, an SSI was defined as any surgical wound in which purulent discharge was observed within 14 days after the procedure. Follow-up for all patients was obtained by direct examination or telephone interviews.

Results—Overall SSI rate in the minimally invasive surgery (MIS) group was 1.7% and in the open surgery (OS) group was 5.5%. On univariate analysis, there was a significantly lower SSI rate in the MIS group, compared with the SSI rate for the OS group. On multivariable logistic regression analysis, this difference appeared to be a result of the fact that surgery times were longer (median, 105 vs 75 minutes) and hair was clipped ≥ 4 hours prior to surgery for more animals (23% vs 11%) in the OS group, compared with the MIS group.

Conclusions and Clinical Relevance—MIS may be associated with a lower SSI rate, compared with OS, but confounding factors such as differences in surgery time and preoperative preparation contributed in part to this finding. As such, surgical approach cannot be categorized as an independent risk factor for SSIs in small animals until further studies are performed. (J Am Vet Med Assoc 2012;240:193–198)

The use of MIS in human medicine has greatly increased over the past 20 years. Many advantages of MIS over traditional OS have been documented. Advantages include a decrease in pain and discomfort and a more rapid return to normal activity after surgery, with fewer wound-healing and other complications.

Minimally invasive interventions are being performed with increasing frequency in veterinary patients, although the advantages of the less invasive approaches have been less well documented in small animals. A reduction in pain and more rapid return to normal activity have been documented in veterinary patients after MIS. No studies have evaluated SSI rates after MIS in small animals, although those associated with OS have been widely reported in the veterinary literature. Clean and clean-contaminated OS procedures are associated with SSI rates of 2.5% to 4.7% and 4.5% to 5%, respectively. Additionally, several risk factors for development of an SSI have been investigated. The use of propofol, a longer duration of anesthesia and surgery, concurrent endocrinopathy, male sex, and clipping of hair at the surgical site prior to anesthetic induction have all been identified as risk factors for SSI in dogs and cats in clean and clean-contaminated wounds.

The goals of the study reported here were to document SSI rates in clean and clean-contaminated wounds after MIS and to compare SSI rates after MIS by use of an existing database of prospectively evaluated OS wounds. The null hypothesis was that there would be no difference in SSI rate between OS and MIS in small animal patients.

Abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>MIS</td>
<td>Minimally invasive surgery</td>
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<tr>
<td>OS</td>
<td>Open surgery</td>
</tr>
<tr>
<td>SSI</td>
<td>Surgical site infection</td>
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OS have been widely reported in the veterinary literature. Clean and clean-contaminated OS procedures are associated with SSI rates of 2.5% to 4.7% and 4.5% to 5%, respectively. Additionally, several risk factors for development of an SSI have been investigated. The use of propofol, a longer duration of anesthesia and surgery, concurrent endocrinopathy, male sex, and clipping of hair at the surgical site prior to anesthetic induction have all been identified as risk factors for SSI in dogs and cats in clean and clean-contaminated wounds.

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Materials and Methods

MIS group—Dogs and cats undergoing minimally-invasive approaches to the pleural or peritoneal cavities at the University of Pennsylvania and Purdue University between March 12, 2007, and August 6, 2008, were prospectively enrolled in the study. Only patients that were undergoing clean or clean-contaminated procedures as defined by the guidelines of the National Research Council20 were included. All patients were aseptically prepared for surgery by clipping the hair at the surgical site and standard surgical scrubbing with antiseptic preparations for recommended periods of time, as described,16 for the OS procedures. Patients were excluded from the study if penetration of the pleural or peritoneal cavity did not occur, MIS was converted to OS intraoperatively, or follow-up including direct examination by a veterinarian or telephone interview with the owner was not possible within 7 to 14 days after surgery.

OS group—Cases from an existing database of 1,574 wounds in 1,255 dogs and cats that were collected by one of the authors (DCB) between July 1, 1994, and June 30, 1995, were used as a comparison population for this study. This database has been used to publish previous epidemiological reports of SSIs in small animal patients.11-15 From this database, only patients in which a clean or clean-contaminated celiotomy or thoracotomy was performed were used for comparison. For both groups, an SSI was defined as any wound in which purulent discharge was seen within 14 days after surgery.13,16 In all patients, the following information was collected: signalment, body condition (cachectic, thin, normal, overweight, or obese), body weight, duration of anesthesia, anesthetic regimen, duration of surgery (skin incision to last suture), type of procedure performed, contamination classification (National Research Council classification15), time of clipping of hair at the surgical site (< 4 hours or ≥ 4 hours prior to anesthetic induction), presence or absence of intraoperative hypotension (defined as a mean arterial blood pressure < 60 mm Hg), detection of an active distant infection, concurrent diagnosed endocrinopathy, administration of known immunosuppressive agent (steroids or chemotherapeutics), and antimicrobial administration (type, dose, and dosing regimen). In the OS group, only patients that had skin sutures placed were included in the database, whereas in the MIS group, a very small number of dogs had no skin sutures placed and only had an intradermal suture pattern for closure of portal incisions.

Statistical analysis—Descriptive statistics were calculated. Continuous data were expressed as median values and ranges, and categorical data were expressed as frequencies. The Fisher exact test was used to compare the number of OS versus MIS procedures that resulted in the development of an SSI within 14 days after surgery. A 2-tailed assessment was used, and values of P < 0.05 were considered significant. Logistic regression analysis was performed to evaluate the association of factors (species, age, sex, body condition score, body weight, surgery time, clipping of hair at the surgical site ≥ 4 hours prior to surgery, use of propofol, development of hypotension, presence of distant infection, presence of endocrinopathy, use of immunosuppressive medication, and OS vs MIS) with the development of an SSI. Univariate analysis was performed initially, and factors with a Wald test value of P < 0.20 were tested in a multivariable model. Factors were retained in the model on the basis of a Wald test value of P ≤ 0.05. Absence of confounding was determined on the basis of a factor changing model coefficients by < 15%. The fit of the overall models was evaluated via the Hosmer-Lemeshow statistic. All analyses, including graphs to evaluate model assumptions, were performed with statistical software.a

Results

MIS group—Data on 201 patients were collected prospectively (Table 1). Of this population, 179 dogs and cats underwent laparoscopic (n = 165) or thoracoscopic (14) procedures and met all the inclusion criteria: 151 from the University of Pennsylvania and 28 from Purdue University. Of 22 patients that were excluded, 9 were euthanized for a variety of reasons within a week after the procedure and the remaining 13 were lost to follow-up. Median age of all patients was 36 months (range, 3 to 192 months). Median weight was 23 kg (50.6 lb; range, 1.7 to 81.9 kg [3.74 to 180.18 lb]). Median surgical time was 75 minutes (range, 25 to 245 minutes). There were 142 clean procedures (79%) and 37 clean-contaminated procedures (21%) in the MIS group. In total, there were 217 procedures performed in 179 patients. The following laparoscopic procedures were performed: laparoscopic-assisted ovariohysterectomy (n = 55), laparoscopic-assisted gastropexy (31), laparoscopic liver biopsy (29), intracorporeally sutured gastropexy (21), laparoscopic-assisted cystotomy (16), laparoscopic ovariotomy (12), laparoscopic-assisted gastrointestinal biopsy (8), laparoscopic adrenalectomy (4), laparoscopic-assisted intestinal resection and anastomosis (4), laparoscopic cryptorchidectomy (3), laparoscopic cholecystectomy (3), laparoscopic-assisted renal biopsy (3), laparoscopic-assisted lymph node biopsy (2), exploratory laparoscopy (2), laparoscopic-assisted feeding tube placement (2), laparoscopic-assisted pyometra resection (2), and laparoscopic-assisted splenectomy (1). The following thoracoscopic procedures were performed: thoracoscopic thoracic duct ligation (n = 3), thoracoscopic subphrenic pericardectomy (5), thoracoscopic pericardial window (4), thoracoscopic lung lobectomy (3), and exploratory thoracoscopy (1). In 174 of 179 (97%) patients, skin sutures were placed in the wounds during portal closure. Three dogs were receiving prednisone at the time of surgery. No other known immunosuppressive agents were being administered in the remainder of patients. Five dogs either had suspected or confirmed hyperadrenocorticism, and 1 dog had diabetes mellitus. In 163 (91%) patients, a postoperative examination was performed by a veterinarian, whereas in 16 (9%) patients, a telephone interview with the owner was used to record the presence or absence of an SSI.

OS group—Of 1,255 dogs and cats that underwent OS abdominal or thoracic procedures at the University
of Pennsylvania, 379 dogs and cats were included in the study. Of these, 363 underwent abdominal procedures and 16 underwent thoracic procedures. This comprised 379 dogs and cats were included in the study. Of these, 363 underwent abdominal procedures of surgery, 7 dogs were receiving prednisone and 1 was undergoing thoracic procedures: lung lobectomy (n = 5), body wall herniorrhaphy (2), liver biopsy (5), mastectomy with ovariohysterectomy (n = 133), cystotomy (29), splenectomy (82), esophagotomy (3), pancreaticoduodenectomy (2), patency ductus arteriosus ligation (2), and epicardial pacemaker implantation (2). At the time of surgery, 7 dogs were receiving prednisone and 1 was receiving dexamethasone. No other known immunosuppressive agents were being administered in the remainder of patients. Six dogs either had suspected or confirmed hyperadrenocorticism, 3 had hypothyroidism, and 1 had hypoadrenocorticism. All patients had skin sutures for closure of their abdominal wounds. In all OS patients, a postoperative examination was performed by a veterinarian at the time of suture removal.

SSIs—Of 179 patients in the MIS group, there were 3 (1.7%) SSIs. One case was a clean-contaminated surgery, and 2 were clean wounds. One laparoscopic-assisted jejunostomy tube placement site became infected at the portal site where the tube exited. One dog undergoing laparoscopic-assisted gastroscopy developed an infection at the most cranial ventral midline instrument portal site. Of 379 patients in the OS group, there were 21 (5.5%) SSIs. Of these, 10 were in clean-contaminated wounds, whereas 11 were in clean wounds. By use of the Fisher exact test, there was a significantly (P = 0.043) lower SSI rate in the MIS group, compared with that in the OS group. On logistic regression analysis, the following 8 variables had a value of P < 0.20 on univariate analysis: MIS versus OS, age, sex, surgery time, clipping of hair at the surgical site ≥ 4 hours prior to surgery, presence of distant infection, presence of endocrinopathy, use of immunosuppressive medication, and OS vs MIS with the development of an SSI.

### Table 1—Clinical characteristics and potential confounding factors for the development of SSIs in 558 dogs and cats undergoing either MIS (n = 179) or OS (379).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>MIS group (n = 179)</th>
<th>OS group (n = 379)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td></td>
<td>162 (91)</td>
<td>267 (70)</td>
</tr>
<tr>
<td>Sex</td>
<td>Dog</td>
<td>17 (9)</td>
<td>112 (30)</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td>155 (88)</td>
<td>155 (40)</td>
</tr>
<tr>
<td>Reproductive status</td>
<td></td>
<td>174 (99)</td>
<td>206 (54)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>173 (99)</td>
<td>206 (54)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>171 (96)</td>
<td>200 (53)</td>
</tr>
<tr>
<td>National Research Council</td>
<td></td>
<td>174 (99)</td>
<td>206 (54)</td>
</tr>
<tr>
<td>Wound category</td>
<td>Clean</td>
<td>143 (79)</td>
<td>229 (60)</td>
</tr>
<tr>
<td></td>
<td>Clean-contaminated</td>
<td>37 (21)</td>
<td>150 (40)</td>
</tr>
<tr>
<td>Time at which hair was clipped</td>
<td>&lt; 4 hours</td>
<td>160 (89)</td>
<td>291 (77)</td>
</tr>
<tr>
<td></td>
<td>≥ 4 hours</td>
<td>19 (11)</td>
<td>88 (23)</td>
</tr>
<tr>
<td>Propofol used during procedure</td>
<td>Yes</td>
<td>97 (54)</td>
<td>27 (7)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>82 (46)</td>
<td>352 (93)</td>
</tr>
<tr>
<td>Intraoperative hypotension†</td>
<td>Yes</td>
<td>71 (40)</td>
<td>90 (24)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>106 (60)</td>
<td>286 (76)</td>
</tr>
<tr>
<td>Presence of distant infection</td>
<td>Yes</td>
<td>8 (5)</td>
<td>22 (6)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>171 (95)</td>
<td>356 (94)</td>
</tr>
<tr>
<td>Concurrent endocrinopathy</td>
<td>Yes</td>
<td>7 (4)</td>
<td>10 (3)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>172 (96)</td>
<td>309 (83)</td>
</tr>
<tr>
<td>Concurrent immunosuppressive treatment</td>
<td>Yes</td>
<td>3 (2)</td>
<td>8 (2)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>176 (98)</td>
<td>371 (98)</td>
</tr>
<tr>
<td>Intraoperative antimicrobial usage</td>
<td>Yes</td>
<td>108 (63)</td>
<td>213 (56)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>95 (53)</td>
<td>206 (54)</td>
</tr>
<tr>
<td>Use of skin sutures</td>
<td>Yes</td>
<td>174 (97)</td>
<td>379 (100)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5 (3)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Values are reported as number (%). *Time relative to induction of anesthesia (< 4 hours or ≥ 4 hours) that the animal underwent clipping of hair at the surgical site. † Occurrence of intraoperative hypotension (defined as a mean arterial blood pressure < 60 mm Hg) at any time during surgery.

Logistic regression analysis was performed to evaluate the association of factors (species, age, sex, body condition score, clipping of hair at the surgical site, *P* value relative to induction of anesthesia (< 4 hours or ≥ 4 hours) that the animal underwent clipping of hair at the surgical site, use of propofol, development of hypotension, presence of distant infection, presence of endocrinopathy, use of immunosuppressive medication, and OS vs MIS) with the development of an SSI.
great odds of SSI, compared with dogs for which hair was clipped at the surgical site < 4 hours prior to surgery (95% confidence interval, 1.7 to 9.3; \( P = 0.001 \)). Controlling for the timing of hair clipping, longer surgical times were associated with an increased SSI rate. For every 90 minutes of surgery time, there were 2.1 times as great odds of an SSI developing (95% confidence interval, 1.2 to 3.4; \( P = 0.005 \)). Surgical technique (MIS vs OS) did not maintain a \( P \) value < 0.05. The importance of the surgical technique was overridden by the finding that the OS group had longer surgical times and more animals for which hair was clipped at the surgical site ≥ 4 hours prior to surgery than did the MIS group, and the SSI rate was driven by those factors rather than the OS versus MIS technique per se.

**Discussion**

The results of the present study suggest that in small animal patients, MIS may be associated with a lower rate of SSIs, compared with OS, but confounding factors may have contributed in part to this finding. For the variety of abdominal and thoracic procedures evaluated in dogs and cats, overall SSI rate in the MIS group was 1.7% and in the OS group was 5.3%. However, this difference appeared to be because of longer surgery times (105 vs 75 minutes) and more animals for which hair was clipped at the surgical site ≥ 4 hours prior to surgery (23% vs 11%) for the OS group, compared with the MIS group. As such, surgical approach cannot be categorized as an independent risk factor for SSI in small animals until further studies are performed.

In human medicine, several studies have evaluated postoperative SSI rate in procedures in which MIS is considered the reasonable standard of care. Laparoscopic cholecystectomy is the most frequently performed MIS intervention in human patients. It has been shown that laparoscopic cholecystectomy is associated with a significantly lower risk of SSI, compared with OS cholecystectomy, in multiple studies.\(^1,4,10,12,21,22\) The same beneficial effect of MIS has been found in studies of laparoscopic colectomy,\(^8,9\) appendectomy,\(^5,7,10\) gastric bypass,\(^6,10\) and splenectomy\(^23\) in human patients. It is frequently assumed in veterinary medicine that reported advantages of MIS in humans might also be realized in companion animals. However, currently, few of these potential advantages have been scientifically evaluated in veterinary patients. The present study is the first to document postoperative SSI rates associated with laparoscopic and thoracoscopic procedures in a large population of veterinary patients.

Care must be taken in the interpretation of the data from the present study. On univariate analysis, it appears that there is an advantage to MIS in minimizing SSI incidence, compared with OS. However, when a multivariate logistic regression model was constructed to control for potential confounding factors, it was found that the difference was at least partly driven by other factors. This highlights the importance of including other known risk factors for SSI in small animals in the model. Previous studies\(^4,10,12\) have reported that anesthesia time, propofol usage, sex, antimicrobial usage, concurrent endocrinopathies, and clipping of hair at the surgical site prior to anesthetic induction are all known risk factors for SSI. Other risk factors, such as the number of personnel in the operating room or the experience level of the primary surgeon (board-certified specialist vs surgery resident), were not included in the model and thus may have been overlooked as possible confounding factors.\(^24\) In the present study, we were careful to record all clinical data pertaining to known risk factors for SSI to enable statistical analysis of potential confounding factors. Although an effect was shown on univariate analysis, enrolling a greater number of patients may have allowed us to confirm MIS as an independent factor imparting relative protection from SSIs, compared with OS.

The reasons why MIS might reduce SSI rates are complex. An interplay of numerous factors, including the presence and type of microorganisms, local wound environment, and systemic immune defense mechanisms, are involved in the etiopathogenesis of wound infections.\(^25\) Number and virulence of microorganisms are major factors in SSI development.\(^26\) It has been shown that the longer surgical incisions are open and exposed to the operating room environment, the greater the bacterial colonization that occurs.\(^27\) This may in part explain why prolonged surgical time is linked to wound infection in many studies\(^16,19,24\) of human and veterinary patients undergoing OS. In the present study, a difference in surgical time was found to be a confounding factor in the logistic regression model and the effect of this difference may have influenced the likelihood of OS wounds appearing to have a greater postoperative infection rate. No conclusions should be drawn with regard to the speed of laparoscopic procedures versus OS from this observation because procedures were not standardized between groups and this difference is as likely to have been driven by procedure-specific factors (eg, surgeon experience level and procedure complexity) as by surgical approach.

It could be hypothesized that a laparoscopic approach that results in less tissue exposure during surgery could result in less opportunity for bacterial colonization of wound margins, compared with OS. Interestingly, hand-assisted MIS procedures that require larger incisions than cannula portal incisions but which are smaller than traditional OS incisions have been shown to be associated with SSI rates that are lower than rates for OS but higher than those for the entirely laparoscopic version of the procedure.\(^28\) Whether there is a direct relationship between degree of tissue exposure or incision length and bacterial colonization remains unknown.

Local tissue defense mechanisms are impaired by the creation of surgical incisions, and it is known that resistance to infection closely parallels the integrity of the capillary network within the wounded tissue.\(^29\) The production of local angiogenic factors in OS versus laparoscopic wounds has been studied, although no differences in vascular endothelial growth factor or endostatin were detected in 1 small study,\(^30\) involving 26 human patients. One factor predictive of the resistance of tissues to wound infection is subcutaneous tissue oxygen tension, with greater oxygen tension imparting a protective effect.\(^31\) However, 1 study\(^32\) comparing
the subcutaneous oxygen tension of wounds during laparoscopy and OS found that laparoscopic interventions were associated with lower oxygen tension when performed by use of a surrogate wound site and a colostomy model. It was hypothesized that this may be a systemic effect of pneumoperitoneum, which is known to increase systemic vascular resistance and decrease cardiocindex, both factors that lead to reductions in tissue oxygen tension. Local effects of pneumoperitoneum on tissue oxygenation may also play a role in these findings.31

Differences in local inflammatory response during OS and MIS have been studied in much greater depth. A variety of factors are important mediators of the local response, including degree of tissue trauma, effects of insufflation gases, and intraperitoneal pressure.31 Local peritoneal production of acute-phase reactants, such as interleukin-6 and protein C, have repeatedly been shown to be less elevated after MIS versus OS, suggesting a lower degree of surgical inflammation associated with MIS.32–35 The effect of insufflation gas is also considerable. It has been shown that air is actually more damaging to local cell-mediated immunity than is CO2, the most frequently used gas in laparoscopy.31 Laparotomy or air-insufflation laparoscopy impaired macrophage phagocytosis to a greater extent than did CO2 laparoscopy in a murine model.36 Others have also found that CO2 impairs the inflammatory response to a lesser extent, compared with exposure of the peritoneum to air.36 Studies39 of peritoneal clearance of inoculated bacteria into the peritoneal cavity have found that clearance of bacteria is less efficient after laparotomy than after CO2 laparoscopy. Overall, it has been concluded that peritoneal cell function is better maintained after laparoscopic interventions, compared with OS.31,34 These local effects may play an important role in the clearance of bacteria from surgical wounds after surgery.

It is known that local peritoneal responses are more pronounced than systemic responses, but the systemic response to surgical stress is also an important factor in the etiopathogenesis of SSIs.2,30 Many studies31,34,38 have compared the systemic effects of OS and MIS, and most, although not all, have concluded that MIS causes less inflammation and detriment to the immune system, compared with OS. Interestingly, in human studies on more invasive laparoscopic interventions such as colectomy, it appears that there is a less dramatic difference in the inflammatory and immune responses between OS and MIS.31,34

Ancillary factors may also play an important role in the likelihood of developing an SSI after surgery. The effect of persistent pain after surgery may be substantial because it can delay the return of normal pulmonary function, delay the withdrawal of indwelling devices such as urinary and intravenous catheters, and prolong postoperative ileus, all of which are commonly associated with the development of SSIs.30,32 It is generally accepted in human medicine that most MIS procedures reduce pain and allow a more rapid return to normal activity, compared with OS.31–33 A reduction in pain and more rapid return to normal activity have also been demonstrated in veterinary patients undergoing laparoscopic ovariohysterectomy, ovarietomy, and gastropexy.12–14 Quantification of this effect would be difficult, but it may be determined in future studies that a more rapid return to normal function in animals undergoing MIS may play a role in minimizing SSIs.

There are several important limitations to the present study. When outcome measures that occur infrequently in the population, such as SSI, are evaluated, very large case numbers are required to find differences with sufficient statistical power. Larger case numbers may have allowed the surgical approach to be evaluated in the multivariate model as an independent risk factor for SSI development. In the present study, patient data in each group were not contemporaneously collected; however, all data that were collected for OS patients were also prospectively collected for the MIS group. This included data on many known risk factors for development of SSIs. Types of procedures within the 2 groups were not closely matched; thus, there may be differences in the inherent susceptibility to infection of the 2 populations that could affect outcomes. Operating room protocols with regard to aseptic preparation of the surgical site and personnel may have been somewhat different between different hospitals and over differing time periods. The authors consider this an unlikely source of important variation because few major changes in the guidelines for operating room asepsis have occurred in the past 15 years. Surgeons of various experience levels were involved in these cases, which may also have had an influence, although a similar mixture of experienced and inexperienced surgeons would likely have been involved in both institutions and both groups (OS and MIS) given that all cases were performed in veterinary teaching hospital environments. There were small differences in case inclusion between databases that could be unknown confounding factors. Only patients that had skin sutures placed were included in the OS database, although patients with and without skin sutures were included in the MIS database. However, 97% of patients in the MIS group had skin sutures placed and their use has never been shown to be a risk factor for wound infections in small animals. Of 179 MIS patients, 16 (9%) did not have an examination by a veterinarian at the time of follow-up. Although this is a small percentage of patients, it is possible that nonexpert observations may have affected outcome. Care was taken to perform telephone interviews within a short period after surgery to minimize the loss of owners’ recollection of events.

References
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