Surgical Sponges in Small Animal Surgery

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Abstract: Sponges are commonly used in veterinary practice. Uses for sponges in the operative arena include hemostasis, retraction, protection, dissection, and general wound management. Blood loss can be quantitated by counting blood-soaked sponges. Complications may arise when sponges are retained in the patient. Sponge retention is a risk whenever sponges are used during surgery, regardless of surgical procedure. This article reviews physical characteristics and proper uses of sponges, complications of sponge retention, and techniques to avoid retained sponges.

The documented medical use of gauze dates back to the late 1800s. Since then, sponges have become one of the most commonly used items in veterinary surgery and are thought to be the most common accidentally retained surgical foreign bodies. Uses for sponges in the operative arena include hemostasis, retraction, protection, dissection, and general wound management. This article reviews the various types and uses of surgical sponges, complications associated with their use, and techniques for preventing retained surgical sponges. Diagnosis and treatment of retained sponges are also addressed.

Sponge Design
Two main categories of sponges are used in veterinary surgery: small sponges and laparotomy sponges. Small square or rectangular gauze sponges come in sizes from 2 × 2 to 8 × 4 inches and are folded to be from 3 to 32 ply. Small sponges are used to absorb fluids, control hemostasis, and keep the surgical field clean and dry. These “free sponges” are frequently thrown away during the surgical procedure. This makes it difficult to account for all of the sponges at the end of the procedure.

Large laparotomy sponges come in sizes from 9 × 9 to 36 × 8 inches. They are used mostly during abdominal and thoracic surgery or in deep wounds to absorb fluids; however, they can also be used to “wall off” the surgical site. The friction of their coarse fibers also allows laparotomy sponges to be used to retract slippery visceral organs. Dry gauze clings to tissues more firmly than wet gauze but may cause more trauma to delicate tissues, which can lead to adhesions.

In addition to square and rectangular sponges, there are small, round sponges, which are used for blunt dissection or for hemostasis. These include “peanut,” “cherry,” and Kittner sponges. Surgical patties or neurologic sponges are small sponges on strings or sticks. These sponges are used for delicate dissection; they can also be interposed between tissue and the suction tip during fluid aspiration to decrease tissue trauma.

Sponges can be made from natural or synthetic fibers or a blend of both (TABLE 1). Most sponges are natural and made of cotton, rayon, or polyester. TABLE 1 provides a comparison of typical woven and nonwoven sponges.

<table>
<thead>
<tr>
<th>Size and Type</th>
<th>Material</th>
<th>Absorption Capacity (mL)</th>
<th>Absorption Time (sec)</th>
<th>Linting (µg)</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woven 4 × 4-inch, 12-ply</td>
<td>Cotton</td>
<td>5–12.5</td>
<td>1</td>
<td>31.2</td>
<td>2.27</td>
</tr>
<tr>
<td>Nonwoven 4 × 4-inch, 4-ply</td>
<td>70% rayon, 30% polyester</td>
<td>10–18.3</td>
<td>1</td>
<td>1.4</td>
<td>1.72</td>
</tr>
</tbody>
</table>
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100% cotton yarn. To improve gauze quality, rayon, a synthetic fiber, was introduced in the 1940s. Virtually all of the nonwoven sponges used in the United States today are made of rayon or synthetic fiber blends (e.g., rayon and polyester). Woven sponges are formed by interlacing two sets of yarn. In contrast, nonwoven sponges are made directly from fibers through a variety of technologies.

Both woven and nonwoven sponges are prone to linting. However, nonwoven sponges produce less lint. For example, a typical 4 × 4–inch, 12-ply woven sponge has been shown to release 31.2 µg of lint, while a 4 × 4–inch, 4-ply nonwoven sponge generates 1.4 µg. Although rarely recognized in veterinary surgery, lint has been associated with an increased risk of granuloma, adhesions, and infection in humans. Manufacturers attempt to reduce the amount of lint by washing sponges.

Laparotomy sponges typically contain a radiopaque marker or ribbon that facilitates detection by radiography (FIGURE 1). The radiopaque inserts are usually made of barium sulfate or plastic. However, the shape of the radiopaque marker may change with folding and twisting of the sponge. Although radiopaque sponges are more expensive, they should be used in all thoracic and abdominal surgical procedures.

Sponges in Surgery

Surgical sponges can be used for several purposes during surgery: hemostasis, protection, retraction, blunt dissection, and wound management.

Hemostasis

Maintaining a dry field is very important throughout the surgical procedure because it facilitates better visualization of anatomic structures in the operative site. Applying direct pressure to low-pressure bleeding vessels with a dry or moistened sponge is an effective way to perform hemostasis after the incision of skin and subcutaneous tissues. Applying pressure to vessels leads to stasis of blood flow, which initiates the coagulation cascade. The tissues should be compressed or blotted for at least 4 minutes, not rubbed or wiped. Gauze is abrasive, and wiping creates microlesions as well as dislodges blood clots. Therefore, rubbing may promote further bleeding. Generalized capillary oozing from an organ such as the liver can also be controlled by pressure pad hemostasis or by packing the wound.

The absorption capacity of a sponge depends on its size, composition, and degree of saturation. Blood loss can be quantitated by counting blood-soaked sponges. A typical dry, 4 × 4-inch, 12-ply woven sponge has been shown to absorb between 5 and 12.5 mL of heparinized bovine blood (FIGURE 2). A comparable 4 × 4–inch, 4-ply nonwoven sponge absorbs between 10 and 18.3 mL of blood. Nonwoven sponges are therefore much more absorbent than woven sponges.

A 12 × 12–inch woven laparotomy sponge moistened with sterile saline solution before use can absorb approximately 50 mL of blood. For this purpose, it can be assumed that a 4 × 4–inch dry sponge has a negligible weight and that 1 mL of blood represents 1 g. Sponges can also be weighed to quantitate blood loss. For this purpose, it can be assumed that a 4 × 4–inch dry sponge has a negligible weight and that 1 mL of blood represents 1 g. Sponges are thought to be one of the most common accidentally retained surgical foreign bodies.

Techniques for reducing the risk of sponge retention include sponge counts, tagging, and the use of radiopaque markers.

Key Points

- Nonwoven sponges absorb more blood and produce less lint than woven sponges.
- Blood loss can be estimated by counting blood-soaked sponges.
- Sponges are thought to be one of the most common accidentally retained surgical foreign bodies.
- Retained surgical sponges can lead to serious complications.
- Techniques for reducing the risk of sponge retention include sponge counts, tagging, and the use of radiopaque markers.
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Protection and Retraction

Once the abdominal or thoracic cavity has been entered, saline-moistened laparotomy sponges are placed around the edges of the incision to protect soft tissues and exposed organs from abdominal or rib retractors (FIGURE 3). The sponges also prevent sliding of the retractors. Further access to the abdomen or the thorax can be facilitated by using more moist laparotomy sponges to “pack off” or separate organs and provide a working space. Organs such as intestines can be held aside in wet laparotomy sponges to keep them moist. The edges of the same sponges can be used for hemostasis or to clean the surgical field.

Sponges may also be used as packing material to protect vital areas or surgical sites from contamination with blood, exudate, ingesta, or feces. They can be placed into the oropharynx to collect blood during oral surgical procedures. Laparotomy sponges can be placed strategically around segments of the gastrointestinal tract that are to be entered or resected. The number of sponges placed should be recorded, and care should be taken to remember to remove these sponges at the conclusion of the surgical procedure.

Blunt Dissection

Sponges can be used to facilitate blunt dissection of delicate tissues by using a single ply of gauze wrapped around the index finger. Procedures in which blunt dissection is used include castration, perineal urethrostomy, and mastectomy.

Wound Management

The use of sponges in wound management has been reviewed elsewhere. Sponges have been used in the primary or contact layer of dry-to-dry, wet-to-wet, and wet-to-dry bandages. In the latter two types, isotonic crystalloid solutions are used to moisten the gauze. Sponges are used to absorb exudates and to facilitate microscopic debridement of soft tissue wounds.

Nosocomial transmission of Serratia marcescens in a veterinary hospital was described by Fox et al. after the use of cotton sponges soaked in 0.025% benzalkonium chloride. This antiseptic loses its bactericidal properties when in contact with cotton fibers because it is absorbed into the fibers and becomes diluted to concentrations that are no longer bactericidal.

Methods for Reducing the Risk of Sponge Retention

Numerous techniques can be used to reduce the risk of sponge retention (BOX 1 and BOX 2). The most basic is to regularly survey the surgical field to identify errant sponges. A small sponge may be difficult to see, especially when it is soaked with blood or buried in a deep surgical field. Small sponges should not be placed inside a body cavity unless they are appropriately tagged. Tagging involves attaching sponges to an instrument, such as hemostatic or sponge forceps. Small sponges should be thrown away once they are blood soaked. Whether they are used or new, they should not be left on the drape or near the surgical field.

Instrument surgical packs should contain a defined number of small or laparotomy sponges. This number will vary with the type of pack or the procedure. Individual sponge packs should also contain a defined number of sponges. Some companies bundle sponges in packs of 10.

Counting sponges before and after a surgical procedure is, unfortunately, not a common practice in veterinary surgery. This quick and simple safety measure is routine in human surgery, in which it is the responsibility of the scrub nurse, who usually performs a triple count. For example, for an abdominal procedure, the count is done before surgery, immediately before closure of the abdominal wall, and after skin closure. A special container

Box 1. Ten Ways to Prevent Retained Surgical Sponges

1. Count sponges before and after the surgical procedure.
2. Routinely survey the surgical field for hidden sponges, and immediately discard any found.
3. Be especially careful when sponges are used for packing off.
4. Throw used 4 x 4-inch sponges away as soon as possible.
5. Never place a free small sponge inside a body cavity.
6. Attach 4 x 4-inch sponges to a hemostat or sponge forceps for use in deep areas.
7. Never leave dry or used sponges on the surgical drapes or near the surgical field.
8. Know how many sponges are supposed to be in surgical packs and sponge packs.
9. Use sponges with radiopaque markers, especially for thoracic and abdominal surgery.
10. Use large laparotomy sponges in abdominal and thoracic procedures.
A study investigated the use of radio-frequency identification (RFID) technology to avoid retained sponges. This technology is used in numerous industries (e.g., to prevent theft in clothing stores). The RFID chips—the size of a nickel—were attached to laparotomy sponges. Human surgeons then used a handheld wand to detect the sponges. Detection accuracy was 100%, with no false-positive and no negative readings. Despite these impressive results, the study authors insist that human error is still possible.

Pittsburgh-based ClearCount Medical Solutions recently attained FDA approval for its SmartSponge System based on RFID technology. The system is “designed to replace the antiquated method of manual counting,” according to a company statement. The technology that improves sponge detection may reduce the risk of retained sponges.

Despite standardized protocols for counting sponges, the problem of retained sponges persists in the operating room. Technology that improves sponge detection may reduce the risk to patients. Radio-frequency identification (RFID) and bar-code systems have been investigated successfully in human surgery. These systems are more expensive than a simple hand count but more effective at tracking discrepancies.

In fact, a difference in count does not always indicate a retained sponge. In one human study, most discrepancies were due to a misplaced item (59%). A documentation error was found in 38% of the cases, and a miscount was responsible only 3% of the time.

Large laparotomy sponges can be used for abdominal and thoracic surgery. Because they are larger, fewer are required and they are easier to see. These sponges have a loop sewn to one corner, usually blue, which can be clamped to the surgical drape. This loop enables the surgeon to know how many sponges are in the surgical field and makes it easier to remove them. The loop is also radiopaque. Despite their large size, these sponges can also be retained in a body cavity and should be counted before and after surgery.

**Complications of Surgical Sponge Retention**

Since the first published report of a retained surgical sponge in human surgery in 1884, surgical sponges continue to be thought of as one of the most common accidentally retained surgical foreign bodies. Retained sponges are a “specter” for surgeons because of the resulting complications and medicolegal implications.

There are no definitive published data regarding the incidence of retained surgical sponges in human or veterinary surgery. One report estimated that sponges are retained in humans approximately once in every 1000 laparotomies. This number may be underestimated because of the reluctance to report this complication. In about one-third of cases, retained surgical sponges cause no clinical signs. Some remain dormant for a very long period of time. In human surgery, surgical sponges have been recovered up to 19 years after the presumptive causative surgery.

The pathophysiology of retained surgical sponges has been well described in the human literature. A retained surgical sponge can be referred to as a gossypiboma, which is a mass composed of a cotton matrix within the body. Retained sponges are also called textilomas, gaucomas, or cottonoids. Sponges are inert and nonabsorbable and, therefore, do not take part in any specific decomposition such as phagocytosis or biochemical reaction such as hydrolysis. However, a retained sponge can result in two types of foreign body reactions. The first one is a classic foreign body granuloma to try to “wall off” the sponge: an aseptic fibrinous response leads to adhesions and encapsulation. In rare cases, calcium may be deposited in the fibrous capsule. The second reaction is exudation and abscess formation, which is usually associated with bacterial invasion. The number of bacteria needed to produce an abscess is reduced in the presence of a foreign body. In some cases, a retained sponge can undergo sterile encapsulation and remain dormant for years.

The abdomen is the most likely location for a sponge to be retained because of the depth of the surgical site and the tortuous nature of the intestines, mesentry, and omentum. However, retained sponges have been recovered from a variety of locations in humans, including the abdominal cavity, the thoracic cavity, the neck, and the lumbar spine. Clinical manifestations of retained surgical sponges depend on the presence of bacterial contamination and the location of the sponge within the body cavity. Complications described in the human and veterinary literature include fistulas, chronic sinus tracts, delayed healing, mechanical intestinal obstruction, peritonitis, adhesions, erosion into adjacent viscera, pancreatic pseudocyst, pseudotumor, pseudothromboma, and hemorrhage secondary to vessel erosion. Several reports of erosion and complete transluminal migration of a retained surgical sponge into the gastrointestinal tract have been published. Extrusion of laparotomy sponges through the rectum has also been reported as a sequela of transmural migration.

**Figure 4.** At the University of Illinois, a special container is used to discard used sponges, which helps in counting them.

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**Box 2. RFID, the Wave of the Future for Surgeons?**

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Few published reports in the veterinary literature concern retained surgical sponges, especially in comparison to the human literature. Teague et al.20 described two cases of foreign body osteomyelitis secondary to retained surgical sponges. In both cases, the gauze was incorporated into the bone and could not be entirely removed. *Staphylococcus aureus* was cultured in both cases. Pardo et al.21 reported a case of a primary jejunal osteosarcoma associated with a retained surgical sponge in a spayed 7-year-old chow chow. A chronic nonhealing sinus wound in the flank of a spayed mixed-breed dog was associated with a retained surgical sponge.22 The radiographic presentation was similar to that of retained surgical sponges reported in the human literature. Several additional cases have been described years after ovariohysterectomy was performed, whether it was elective or as treatment of pyometra.23–26

Other reported cases of sponge retention involve perineal herniorrhaphy,23 laparotomy to remove a cryptorchid testicle,24 celiotomy for intestinal biopsy,24 and a bite wound to the thigh.24 One case of osteosarcoma, presumed secondary to a retained sponge, was diagnosed 9 years after surgery for anterior cruciate ligament rupture.27 In another case, a retained sponge near the bladder caused hematuria and mimicked a bladder tumor on ultrasonography.26

**Diagnosis**

Diagnosis of a retained surgical sponge can be difficult, particularly if the sponge does not contain a radiopaque marker. A retained surgical sponge may be suspected in a patient with a history of a surgical procedure. Clinical signs depend on the location of the retained sponge and the physical disturbance it causes. Signs may include a palpable abdominal mass, chronic pain in the vicinity of the surgical site, vomiting, peritonitis, postoperative ileus, tenesmus, protrusion of a sponge through the rectum, bladder disturbances, abscess formation, fever, signs of sepsis, fistulas, or sinus tracts.4,18 In some animals, the retained sponge causes no clinical signs, and the sponge is an incidental finding.

Retained surgical sponges have various appearances on survey radiographs.17,22 The presence of gas trapped between the fibers gives a characteristic whirl-like configuration (FIGURE 5). The origin of this gas can be the atmosphere, the intestines, or bacteria.3 Peripheral calcification can sometimes be seen.3 The presence of a radiopaque marker can greatly facilitate the diagnosis of a retained surgical sponge14 (FIGURE 6). However, these markers can sometimes be missed because of overlying bony structures.19 At least two orthogonal radiographic views should be used when trying to detect a retained surgical sponge.

In human surgery, one study suggests that routine radiographs taken intra- or postoperatively in “selected, high-risk categories of operations” could be used as a screening test for retained sponges.28 This method is judged to be cost-effective compared with the cost of the potential medical and legal complications.28 The high-risk cases identified in the study are those involving an unexpected change in procedure, emergency surgeries, and overweight patients.28

Upper gastrointestinal series (“barium swallow”) or barium enemas can be helpful if the contrast agent delineates an intraluminal sponge.1,17,18,20 A fistulogram or a sinogram can be a useful technique to characterize a fistulous or a sinus tract, particularly if the contrast material fills the network of the gauze.3,17,22,24 (FIGURE 7).

Other imaging techniques have been used to detect retained surgical sponges but sometimes have limited specificity. With ultrasonography, retained sponges strongly attenuate the sound beam, creating an intense and sharply delineated acoustic shadow.19 A hypoechoic mass with an irregular hyperechoic center was also described.24 Computerized tomography of a retained surgical sponge is useful to identify the sponge and its associated calciﬁcations.25

**Figure 5.** Ventrodorsal abdominal radiograph from a spayed mixed-breed dog demonstrating a retained sponge. Note the whirl-like configuration characteristic of gas trapped between the fibers.

**Figure 6.** Lateral abdominal radiograph of an 8-year-old female German shepherd. The radiopaque marker of a laparotomy sponge is visible. The only surgery performed was an ovariohysterectomy 7 years prior.

**Figure 7.** Fistulogram after a contrast agent was injected in an open wound in the right flank of the dog depicted in Figure 5.
surgical sponge reveals a heterogeneous density that depends on the presence of gas trapped within the mesh.14,19 Magnetic resonance imaging characteristics of a retained surgical sponge are those of abnormal fluid collections of high protein content such as abscesses and exudates.19

Treatment
Once diagnosed, retained surgical sponges can be retrieved by exploratory surgery (FIGURE 8) or laparoscopy.13,20,21,22,27 Acutely retained sponges can be removed by reexploring the surgical site. Adhesions should be gently broken down to free the sponge. Chronically retained sponges may appear as discrete, encapsulated nodules or diffuse adhesive lesions involving several visceral structures, such as the intestines (FIGURE 9). Well-encapsulated sponges should be removed in toto to ensure that all sponge fibers are removed. When this is not feasible, the capsule can be incised and the sponge removed. Occasionally, en bloc resection must be performed to ensure removal of the sponge. Care must be taken not to injure vital structures during dissection.

Surgical sponges can be identified by histopathologic examination. Cotton fibers in a pathologic specimen are virtually invisible under normal light. However, they are visible under polarized light.20

Conclusion
Despite their simplicity, sponges provide an effective means of achieving hemostasis and estimating intraoperative blood loss. Retained surgical sponges are a very important medicolegal problem in surgery, and they will remain a problem as long as nonabsorbable materials are used in the manufacture of surgical sponges. It is conceivable that minimally invasive surgery will decrease the risk of retained surgical sponges. Research is needed to develop materials that would combine the advantages of woven and nonwoven sponges. Until the ideal sponge is manufactured, surgeons need to avoid retained surgical sponges. Some of the best ways to minimize the possibility of forgetting a sponge include awareness of the risk, tagging, using radiopaque markers, immediate sponge disposal, and sponge counts.

References
1. Which of the following methods is/are effective for minimizing sponge retention?
   a. discarding sponges immediately after use
   b. using laparotomy sponges
   c. tagging sponges with surgical instruments
   d. all of the above

2. Which statement concerning RFID technology is true?
   a. In one study of its use in laparotomy sponges, detection accuracy was 100%.
   b. Radiography is used to detect sponges with RFID chips.
   c. RFID stands for request to find inappropriate devices.
   d. Ultrasonography is used to detect sponges with RFID chips.

3. How much blood can a 4 x 4–inch, 12-ply woven sponge absorb?
   a. <5 mL
   b. 5 to 12.5 mL
   c. 12.5 to 15 mL
   d. 15 to 20 mL

4. Compression with a sponge initiates clotting by
   a. initiating stasis of blood flow.
   b. creating microlesions.
   c. acting as a foreign body.
   d. all of the above

5. Assuming that a 4 x 4–inch dry sponge has a negligible weight, how much would it weigh if it is soaked in 5 mL of blood?
   a. 2.5 g
   b. 5 g
   c. 7.5 g
   d. 10 g

6. What are the two main foreign body reactions commonly associated with retained surgical sponges?
   a. fistula and abscess formation
   b. foreign body granuloma and sinus formation
   c. sterile encapsulation and abscess formation
   d. foreign body granuloma and abscess formation

7. Which statement concerning the absorptive capacity of sponges is true?
   a. Nonwoven sponges absorb more blood than woven sponges.
   b. Woven sponges absorb more blood than nonwoven sponges.
   c. Nonwoven sponges and woven sponges absorb equal volumes of blood.
   d. The greater absorptive capacity of woven sponges is related to their greater absorption rate.

8. What is the origin of gas within a retained sponge?
   a. atmospheric air
   b. intestinal gas
   c. bacteria
   d. all of the above

9. Which statement concerning use of a surgical sponge for hemostasis is true?
   a. Direct pressure for 4 seconds is recommended to achieve hemostasis.
   b. Wiping is the most effective way to achieve hemostasis.
   c. Wiping disrupts blood clots and should be avoided.
   d. none of the above

10. Most woven surgical sponges are made of
    a. silk.
    b. rayon and polyester.
    c. wool and cotton.
    d. cotton.