Nicholas Mistretta

SOFT TISSUE SURGERY

Surgical Drains: Placement, Management, and Removal

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In part 1 of this series ("Surgical Drains: Indications, Types, and Complications" in the May/June 2019 issue of *TVP*), we discussed indications for drain use, types of drains, and complications associated with drain use in veterinary surgery. Here, in part 2, we will discuss proper placement of the different types of drains, how to manage them after placement, and when to remove them. Proper placement is important for maximizing drain function; proper management is critical for avoiding complications; and knowing when to remove the drain will ensure that it is not removed too early (which can lead to fluid accumulation) or too late (which can increase the risk for infection, add to patient morbidity, and increase costs associated with prolonged hospitalization). We will discuss placement, management, and removal for each drain type: passive, active (Jackson-Pratt, thoracostomy), and negative-pressure wound therapy (NPWT). Although thoracostomy tubes are a type of active drain, techniques differ enough that they will be discussed separately.

ALL ABOUT DRAINS
Our second article in a 2-part series on drains examines proper drain placement techniques and postoperative care, including avoiding complications.

PASSIVE OR ACTIVE DRAINS

Placement

Preparing the site

Proper placement of drains often begins during surgical preparation. The patient should be prepped (clipped, scrubbed, and draped) with sufficient margins to allow drain placement away from the primary incision or wound. In most cases, placement of active suction drains in the peritoneal cavity will not need additional considerations, but many wound cases or surgical oncology cases take more planning, depending on the type of drain used. If using a passive drain, you must also prep the most dependent area, which will be used for the drain exit.

Determining the exit location

When determining the exit point for a drain, there are a few general rules to consider. Do not exit a drain though the main incision site. Doing so will provide an entry point for bacteria along the entire length of the incision, will increase the

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risk for incision infection and dehiscence, and could compromise the tissue if future reconstructive surgery is needed.[1] Longer subcutaneous tunneling may help decrease ascending infections.

Placing the drain

After the patient is prepped and the exit location has been identified, you are ready to place the drain. Using aseptic technique, insert an appropriately sized hemostat into the debrided wound or surgical incision. The tip of the hemostat is then tunneled through the healthy subcutaneous tissue and pressed against the skin at the exit point. If an abdominal drain is being placed, the hemostat is bluntly forced through the body wall (**FIGURE 1A**). Using a scalpel blade, make a small incision over the tips of the hemostat and push the hemostat through the stab incision (**FIGURE 1B**). The incision should be the same size as the diameter of an active drain or slightly larger than the diameter of a passive drain. The end of the drain then is grasped and pulled into the wound or abdominal cavity (**FIGURE 1C**). Premoistening the drain with sterile saline can help reduce friction when you pull the drain through the exit site.

Securing the drain

For the drain to function properly, securing it is critical. Passive drains are secured at the exit with 1 or 2 simple interrupted sutures. Active drains are usually sutured with a purse-string suture to create a seal and a finger-trap suture to hold it in place (**FIGURES 2, 3**).

There is some controversy about tacking the proximal portion of a passive drain within the wound. Additional tacking sutures are not recommended and are typically contraindicated because they create a risk for the drain to break or tear, leaving fragments in the wound. If absolutely necessary, you can place a single percutaneous simple interrupted suture in the proximal portion of the drain to hold it in place. This suture should be clearly indicated in the medical record so that all personnel are aware of its presence and can avoid having any portion of the drain break off within the wound if it is pulled without cutting all sutures holding it in place.

Protecting the drain

Regardless of the drain type, the exit site should be covered with sterile absorbent dressing to minimize risk

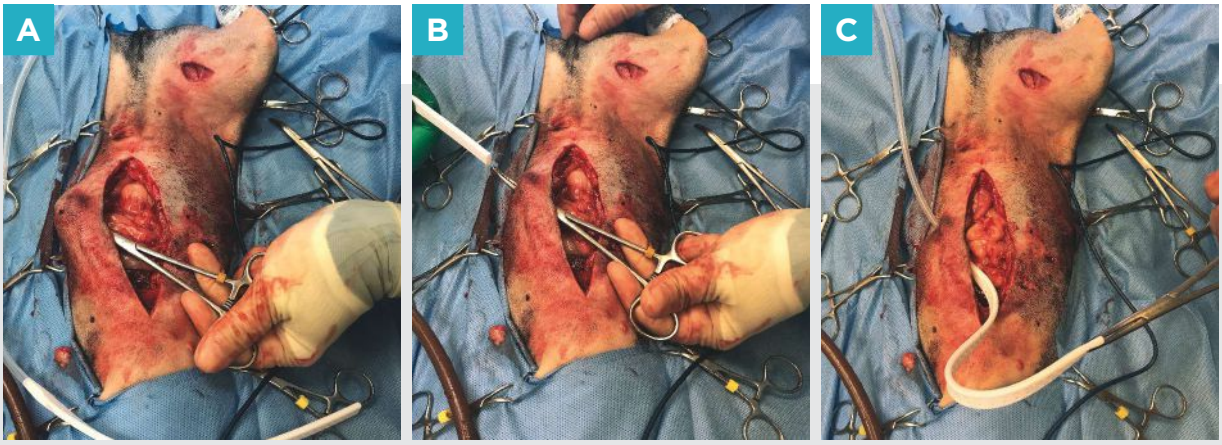

FIGURE 1. Placement of a closed suction drain in the peritoneal cavity. **(A)** A hemostat is placed in the peritoneal cavity. The drain is bluntly pushed through the body wall and pushed against the skin. **(B)** A stab incision is made over the hemostat, and the hemostat is pushed through the stab incision. **(C)** The drain is grasped and pulled through the skin, subcutaneous tissue, and muscle; it is then placed within the peritoneal cavity.

for ascending infection, to collect exudate, and prevent skin excoriation. This covering is especially critical with passive drains. In regions of the body not amendable to bandaging, a tie-over bandage can be placed over the exit site and changed as often as necessary to prevent strike-through.

Management

The risk for bacterial colonization increases with the length of time a drain is kept in place; therefore, drains should be removed as early as possible.[1] To determine when the drain can be removed, assess fluid quality and quantity one or more times a day. Follow aseptic technique when changing bandages, when cleaning drain exits, and when emptying the drain reservoirs.

In closed suction drains, such as a Jackson-Pratt drain, suction is applied to pull fluid from the wound or abdomen. Suction can be continuous or intermittent; however, continuous suction is most often used and is recommended. Continuous suction minimizes infection that can result from opportunistic bacteria in static fluid. For intermittent suction, it is recommended to aseptically empty the reservoir every 6 hours; however, for very effusive wounds, the reservoir may need to be changed as often as every hour.[1]

Active drains rely on having a seal at the drain exit to maintain negative pressure. Air can be pulled into the wound and negative pressure lost if the drain exit is too large, if a purse-string suture is not in place, or if there is dehiscence of the primary incision. For minor leaks through the incision or the drain exit, antibiotic ointment and occlusive dressing can be used to seal the leak. For larger leaks, compressive bandages may be necessary to create a seal. In some cases of incision dehiscence, surgical revision is needed.

Most commercial active drains have compressible reservoirs. To create negative pressure, empty the reservoir and then compress it by hand to remove the air through an open vent. The vent is then occluded so the vacuum is applied to the drain tube and the reservoir naturally expands. One in vitro study revealed that compressible reservoirs lose suction rapidly as they fill to 20% to 30% capacity, and more gradually with further filling, and that some units lose all suction before they are full.[1] Therefore, if a large amount of drainage is expected, use of a larger reservoir is recommended and the reservoir should be emptied when half full.

Removal

Timing of drain removal is based on the quantity of the fluid and its cytologic appearance.

Fluid quantity

The quantity of the fluid produced can not only indicate when a drain can be removed, but it can also indicate a problem. To assess fluid quantity with passive drains, weighing the bandage material before and after bandage placement will give you a rough idea of how much fluid has been absorbed. Unfortunately, evaporation through

FIGURE 2. The exit of a closed suction drain correctly placed away from the primary incision. Note the indentations of the skin from the purse-string suture near the drain exit. A finger-trap suture, which is securing the drain in place, can also be seen.

FIGURE 3. A closed suction drain in place. Note the location of the drain away from the primary wound closure and the presence of a finger-trap suture.

the bandage makes weighing the bandage a crude indicator of fluid production. Fluid quantity can be more precisely assessed with active suction drains. Each time the reservoir is emptied, the amount of fluid should be quantified and recorded. Note that fluid production will never cease while the drain is in place because the presence of a drain will cause tissues to produce fluid. As a general rule, the presence of a drain will lead to production of 1 mL/kg/day of fluid, and this figure is often used to determine when the drain should be removed.[1] More often, however, instead of waiting until the volume has reached the 1mL/kg/day threshold, drains are removed when fluid production is significantly reduced and the trend over several days indicates that fluid production is decreasing.

Fluid quality

Cytologic appearance of the fluid collected from drains can be used to evaluate progression of wound healing. When collecting fluid from passive drains, hold a sterile blood collection tube under the drain to collect some of the effusion. For active drains, connect a new, sterile syringe directly to the drain instead of collecting fluid that has been sitting in the drain reservoir for a long time. In healing tissue, the overall cellularity should decrease and the appearance of the neutrophils should improve from toxic, or degenerate, to well-preserved and nondegenerate.

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The presence of bacteria can also be assessed; however, absence of bacteria in cytology samples is not 100% sensitive for ruling out infection. For abdominal drains, if there is any concern for continued or new infection in the peritoneal cavity, you can compare glucose and lactate levels in the drain fluid with those in the peripheral blood. A greater than 20 mg/dL decrease in abdominal glucose compared with peripheral blood glucose is 100% sensitive and 100% specific for diagnosing septic peritonitis in dogs and 86% sensitive and 100% specific for diagnosing septic peritonitis in cats.[2] In dogs, a difference of less than or equal to 2.0 mmol/L in blood and fluid lactate levels is also 100% sensitive and specific for diagnosing septic peritonitis.

Procedure

For both passive and active drains, removal involves cutting any sutures that were used to secure them and applying gentle traction to remove them. Although drain removal can be uncomfortable for the patient, sedation is seldom needed. Leave the drain exit wound open to heal via second intention. To prevent ascending infection, apply a soft padded bandage for the next 3 to 5 days; you may also apply a thin layer of antimicrobial ointment. If the drain was placed in an infected wound, perform a second culture at the time of drain removal to ensure resolution of existing infection.

THORACOSTOMY TUBES

Placement

Thoracostomy tubes are necessary when large volumes of air or fluid need to be removed in either a frequent intermittent or continuous manner. They can also be used to deliver local anesthetic after thoracic surgery. Thoracostomy tubes should be flexible yet resistant to collapse. To place the tube(s), use aseptic technique with the patient typically in lateral recumbency. In most cases, these tubes are placed with the patient under general anesthesia; however, in emergency situations this is done with sedation or local anesthesia. The area is clipped, scrubbed, and draped. Ideally, the tube should terminate near the second rib; you should premeasure the tube to prevent it from entering the cranial mediastinum. Before inserting the thoracostomy tube into the thorax, place a tube clamp specifically designed for use in chest tubes. Make a small incision, approximately the diameter of the tube, in the dorsal third of the thorax at the level of the tenth or eleventh intercostal space. Then make a tunnel in the subcutaneous tissue to provide a "flap valve" effect that limits entry of air into the pleural space. The tunnel is also deep to the caudal border of the latissimus dorsi. This tunnel can be created in numerous ways. After making the initial skin incision, retract the skin cranially to the level of the seventh or eighth intercostal

space, using large hemostatic forceps to tunnel from the skin incision and then inserting the tube into the chest at the level of the seventh or eighth intercostal space. Last, the thoracostomy tube and trocar can be used to create the tunnel and enter the thorax. Using the thoracostomy tube and trocar to enter the pleural space will require a large amount of force. We recommend placing one hand at the distal aspect of the tube approximately 2 to 3 cm away from the patient's body; this hand will prevent the tube from advancing too deeply into the thorax and causing trauma to intrathoracic organs. With one hand on the distal aspect of the tube, use the other hand to apply force to enter the thorax. After the tube is in the thorax, aim the trocar at the contralateral elbow and hold it in a fixed position while advancing the thoracostomy tube.

Compress the thoracostomy tube by using the preplaced clamp or hemostatic forceps as the trocar is being removed and cap the end with an adaptor and stopcock mechanism. To avoid dislodgement or extrapleural migration of the fenestrations, fix the thoracostomy tube in place by placing a purse-string suture in the skin at the exit site to form a seal and applying a second suture in a finger-trap pattern. Then evacuate the pleural space manually with a syringe until negative pressure is achieved. Take postoperative radiographs to ensure adequate drain placement. A small local bandage using sterile gauze can be applied to prevent nosocomial infection, or a larger bandage can be applied if necessary to cover additional wounds. Orthopedic wire is often used to attach adaptors and stopcocks to ensure that they are not accidentally removed, which could lead to sudden pneumothorax.

Management

For non–life-threatening air or fluid accumulation, intermittent suction is adequate; however, for medical management of pneumothorax, chylothorax, or pyothorax, continuous drainage maybe necessary. For prevention of life-threatening iatrogenic pneumothorax, all personnel involved with draining the thoracostomy tube must be properly trained. Between aspirations, the clamp is compressed with a metal C-clamp (or the preplaced plastic clamp) and sealed with an adaptor and capped with a 3-way stopcock to decrease the risk of air entry between aspirations. Record the amount of air and fluid separately for each thoracostomy tube. The frequency of aspiration is typically high every hour for the first several hours, then tapers down as the fluid and air accumulation decrease and the patient's clinical signs resolve.

Removal

Thoracostomy tubes can be removed when the air leak appears sealed, fluid volumes have markedly decreased, and/or cytologic appearance of the fluid seems to be improving without evidence of infection.[3] The criteria for removal of thoracostomy tubes are similar to those for closed suction drains.

NEGATIVE-PRESSURE WOUND THERAPY

NPWT refers to the application of foam dressing and use of a vacuum evenly distributed across a wound. Wounds that are ideal for use of NPWT are those that are highly exudative and caused by trauma. The principles for wound preparation for vacuum therapy are the same regardless of the dressing applied to the wound: debridement of necrotic tissue and devitalized tissue and copious lavage.

Placement

NPWT can be frustrating to manage if not applied correctly; therefore, meticulous initial application of the dressing can save a lot of future time. Typically, NPWT is applied while the patient is under general anesthesia; however, subsequent reapplication can be applied with the patient under sedation only. NPWT application and changes should be performed with aseptic technique. Before applying the foam dressing, clip and scrub the wound with wide margins, a minimum of 3 to 5 cm around the wound to allow adequate contact with the adhesive drapes. For the last scrub of the skin around the wound, use alcohol, which will aid as a drying agent. To allow the adhesive drape to be in contact with the skin and form a seal, it is very important that the skin around the wound be completely dry before NPWT is applied.

After the wound is prepped, debrided, and dried, apply a thin coating of liquid skin adhesive to the skin 3 to 5 cm around the wound. If the wound vacuum is applied to uneven surfaces (e.g., between the digits), stoma paste or hydrocolloid gels can be molded into a dam to help ensure an airtight seal.[4] Cut the foam dressing to fit within the wound (**FIGURE 4A**), being careful not to apply the foam to the skin. If applying NPWT to a graft, cut the foam to cover the incision. To hold the foam in

place, you can use sutures or skin staples to tack the foam to itself or the patient's skin. After the foam dressing has been fitted into the wound, seal the entire area with impermeable, adhesive drapes (**FIGURE 4B**). Be careful to avoid wrinkles or folds in the drapes because they can prevent an airtight seal from forming and compromise the integrity of the dressing.

To place the proprietary adhesive fenestrated disc associated with the evacuation tubing, cut a small 2-cm round hole in the sheet covering the wound to expose an area of foam dressing. Then connect the evacuation tubing (**FIGURE 4C**) to the tubing on the reservoir canister of the programmable vacuum pump. The pump can typically be set to either intermittent or continuous negative pressure in the range of –75 to –125 mm Hg. Dogs tolerate either intermittent or continuous therapy; cats, however, sometimes seem to resent the restarting of the vacuum in intermittent mode.[4] For NPWT applied over a graft, we recommend setting the pressure at –75 mmHg. When the pump reaches its preset vacuum level, it becomes quiet and activates only intermittently; listen closely for sounds of leakage, and add more adhesive draping as needed. If the wound vacuum is placed on a limb, the tubing can be coiled and a soft padded bandage can be applied. Larger dogs can wear a vest, and the pump can be carried with them. For small dogs and cats, the vacuum pump is placed outside the cage; the pump can be transported with dogs when they are walked.

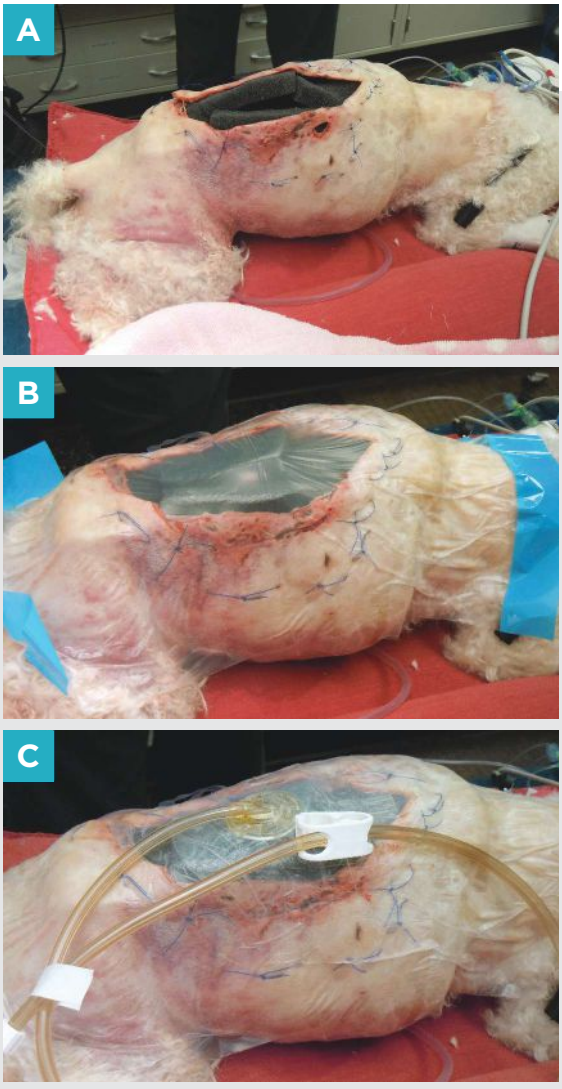

FIGURE 4. Placement of open-cell foam in a large wound. **(A)** The foam is within the wound, avoiding any contact with the skin. **(B)** Placement of an adhesive impermeable drape. **(C)** Demonstration of the connecting tubing. Comparison with panel B shows that the foam is collapsed and negative pressure has been established.

Management

For NPWT, the wound needs be redressed every 48 to 72 hours. The dressing should not be in place for longer than 72 hours because granulation tissue may grow into the interstices of the foam. It is important to maintain aseptic technique when changing the dressing. The entire adhesive drape and foam, or just the portion over the foam, can be removed. After the wound is flushed, new foam and adhesive drapes are placed over the original drape.

Dressing integrity and machine function should be closely monitored; the pump is designed to trigger an alarm when pressure is lost. If the vacuum is lost for more than 2 hours, the dressing will become occlusive and wound maceration will occur.

Removal

When NPWT is used for acute traumatic wounds, it typically takes only 1 to 3 bandage changes before healthy granulation tissue is present. After a healthy granulation bed is present, the wound vacuum can be removed and wound bandaging can continue, to allow second intention healing and closure of wound edges, or a skin graft can be applied to close the defect.

KEY POINTS

- Although use of drains is a very useful part of wound care, their use cannot compensate for inadequate debridement, inappropriate wound care, or improper surgical technique.

- For passive drains, the exit site should be the most dependent area of the patient.
- Passive drains should be covered with an appropriate bandage to minimize complications.
- For active drains, proper securing and sealing are essential for function.
- For thoracostomy drains, staff training is crucial for avoiding iatrogenic pneumothorax.
- NPWT should be monitored closely to avoid loss of vacuum for more than 2 hours, which can lead to wound maceration.
- The timing of drain removal should be based on fluid quantity and quality. TVP

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Additional Resource

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