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An Overview on Prophylactic Sub-Cutaneous Drain

Amr El Sayed Tawfek Ibrahim, Mohammed Abd-Allah Mohammed Sakr*, Essam Saad Abd-Elwahed Soliman, Nezar Mohamed Hosney Abd-Elal El-Nahal and Amr Hassan Mansour

Cardiothoracic Surgery Department, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Mohammed Abd-Allah Mohammed Sakr

Abstract:

Sternal wound infection (SWI) remains one of the most serious complications following median sternotomy in cardiac surgery, particularly among high-risk patients such as those with obesity, diabetes mellitus, chronic obstructive pulmonary disease, renal impairment, or prolonged operative time. Fluid accumulation in the subcutaneous tissue, including hematoma and seroma formation, plays a crucial role in the pathogenesis of surgical site infections. Prophylactic subcutaneous drainage has been proposed as a preventive strategy aimed at reducing dead space and evacuating fluid collections to minimize infection risk.

Keywords: Median sternotomy; Sternal wound infection; Deep sternal wound infection; Subcutaneous drain; Cardiac surgery; Surgical site infection prevention; High-risk patients.

Introduction:

Sternal wound infection (SWI) remains a major postoperative complication following median sternotomy and continues to pose significant challenges despite advances in surgical technique and perioperative management. The reported incidence of SWI varies according to patient risk profile and surgical complexity, but even low percentages translate into substantial morbidity, prolonged hospitalization, repeated surgical interventions, and increased mortality. High-risk populations such as obese and diabetic patients demonstrate disproportionately higher infection rates, highlighting the need for additional targeted preventive strategies beyond standard antimicrobial prophylaxis and meticulous surgical technique **(1).**

The pathogenesis of SWI is strongly linked to postoperative fluid accumulation within the subcutaneous tissue and retrosternal space. Hematoma and seroma formation create dead space that facilitates bacterial colonization, impairs local perfusion, and compromises antibiotic penetration. Therefore, strategies aimed at minimizing dead space and evacuating fluid collections have gained increasing attention as adjunctive preventive measures. Mechanical approaches, including improved sternal fixation techniques and optimized wound management, have been investigated to reduce this risk **(2).**

One of prophylactic measurements of SWI is use of prophylactic sub-cutaneous drain

The use of a **prophylactic subcutaneous drain** after median sternotomy is intended to prevent accumulation of blood and serous fluid in the subcutaneous layer, thereby reducing the risk of wound infection and promoting better healing. Recent clinical studies have demonstrated that prophylactic subcutaneous suction drainage significantly lowers the incidence of superficial and deep sternal wound infections **(3).**

- **Mechanism of Action of Subcutaneous Drains**

Prophylactic subcutaneous drains are surgical devices strategically placed in the subcutaneous tissue layer to prevent the accumulation of fluid, such as blood (hematoma) and serous fluid (seroma), in the surgical wound. The primary mechanism of action revolves around the principle of evacuating these fluid collections, thereby eliminating potential dead spaces. A dead space, if left unfilled by tissue or fluid, can become a breeding ground for bacteria, as it provides a nutrient-rich environment and impairs the local immune response by hindering the delivery of oxygen, antibiotics, and immune cells. By actively or passively removing these fluids, drains contribute to **several beneficial effects: (1, 2)**

Evacuation of blood and fluid collections:

Drains facilitate the removal of extravasated blood and serous fluid that naturally accumulate in the surgical bed post-operatively. This prevents the formation of hematomas and seromas, which are known risk factors for infection **(1, 2)**.

Reduction of dead space:

By applying negative pressure to the deep layers it causes collapseof the potential spaces where fluid could collect, drains help to approximate tissue layers, promoting adherence and reducing the volume available for fluid accumulation. This minimizes the environment conducive to bacterial proliferation **(1, 2)**.

Discouraging bacterial growth:

Stagnant fluid collections are excellent culture media for bacteria. By continuously removing these fluids, drains reduce the bacterial load and prevent the establishment of an infection. The negative pressure created by some drain types (e.g., Hemovac) can further aid in this process by drawing out fluid and potentially reducing bacterial migration **(1, 2)**.

Minimizing hematoma formation and pressure on tissues:

Large hematomas can exert pressure on surrounding tissues, compromising blood supply and oxygenation, which in turn impairs wound healing and increases susceptibility to infection. Drains alleviate this pressure, promoting better tissue perfusion and supporting the natural healing process **(1, 2)**.

- **Insertion of subcutaneous drain**

A drain is typically inserted through a separate puncture site a few centimeters away from the surgical wound. The tubing often features a sharp end (trocar) for skin penetration, with multiple perforations on the opposite end for drainage. To use the trocar, make a small stab incision in a sterile area a few centimeters from the surgical site and pull the tubing through, ensuring the perforated section remains within the body cavity. Alternatively, surgical forceps can position the tubing in the desired location. The tubing should be trimmed to the required length. Once positioned, the tubing is secured to the skin with a nonabsorbable suture and a sterile dressing. The insertion site must be sealed tightly to prevent leakage and ensure proper fluid and air drainage. Multiple loops around the tubing may be used for secure position. once the skin wound is closed and a dressing is applied, the tubing is connected to a collection system, such as a bulb, bottle, or other drainage device Depending on the surgeon's instructions, the drainage output is measured, discarded, or sent for analysis. **Initially**, drainage may be sanguineous, followed by serosanguineous or serous fluid. The surgeon should be notified of any significant changes in the amount or quality of drainage **(4).**

- **Management of Suction Drain**

Effective management of suction drains requires a collaborative, patient-centered approach. Each healthcare professional plays a specific and essential role in ensuring optimal outcomes and preventing complications.

Clinicians are responsible for selecting the appropriate type of drain based on the clinical condition, ensuring correct insertion, and monitoring for complications such as infection, blockage, or poor drainage. They also make decisions regarding the timing of drain removal.

Nurses are involved in the daily care of the drain site, including observing for signs of infection (e.g., redness, swelling, or discharge), maintaining hygiene, and assisting with dressing changes. Additionally, they play a key role in **educating the patient** on how to care for the drain at home after discharge.

Pharmacists support patient care by recommending appropriate antimicrobial therapy when needed and managing medications related to wound healing or infection prevention. They also help manage pain or inflammation that may be associated with the use of the drain.

Interdisciplinary communication is essential. Regular updates and coordination between team members allow for early recognition of issues like blockage, leakage, or abnormal drain output. For example, a clinician may

consult the nursing staff regarding changes in fluid characteristics, while the pharmacist may suggest antimicrobial adjustments to prevent infection.

This coordinated teamwork not only enhances the safety and comfort of the patient but also supports faster healing and reduces the risk of prolonged hospital stay. Regular documentation and team discussions ensure that all providers remain aligned with the patient's care plan and treatment goals **(5).**

Subcutaneous drains must be carefully managed to prevent complications such as blockage or infection. The tubing should be regularly "stripped" by gently pinching and sliding along it to prevent clogging. This should be done using hand hygiene and alcohol to reduce friction.

The collection bulb **(e.g., JP drain)** is emptied when full. It should be handled using sterile technique. To restore negative pressure, the bulb is compressed and sealed before release. It may be pinned to the patient's clothing to avoid tension **(6)**.

♦ **Monitoring Drain Output**

- Drainage should be measured at regular intervals (typically every 8–12 hours).
- The **volume**, **color**, and **consistency** of the fluid must be documented.
- Initially, the fluid is usually **sanguineous** (bloody), progressing to **serosanguineous** and finally **serous** as healing advances.
- A **sudden increase** in output, return to bloody drainage, or appearance of **cloudy, foul-smelling**, or **purulent** fluid may indicate bleeding or infection and should be reported promptly**(6)** .

♦ **Drain Site Care**

- The exit site should be kept clean and dry using sterile dressings.
- The area must be inspected daily for signs of infection (e.g., redness, swelling, warmth, discharge).
- Securement of the tubing must be checked to prevent accidental dislodgement or kinking **(6).**

♦ **Decision for Drain Removal**

- Drains could be removed in most cases when:

✓ The output is minimal when the drainage volume was less than 40 mL of serous fluid for 2 consecutive days (depending on surgical site and surgeon preference).

✓ There are no signs of active infection or bleeding **(7).**

Procedure:

✓ Remove anchoring suture.

✓ Gently pull the drain in a steady motion.

✓ Apply sterile dressing and monitor for leakage.

✓ Prolonged drain use may increase infection risk, so timely removal is very essential **(7).**

Laboratory analysis of the tip or for the drain may be needed or recommended. The drain site should be covered with a sterile pressure dressing and changed as needed **(8)**.

♦ **Types of subcutaneous drains**

1. **Passive Drains:** No suction—they rely on gravity or capillary action.

Example: Penrose drain

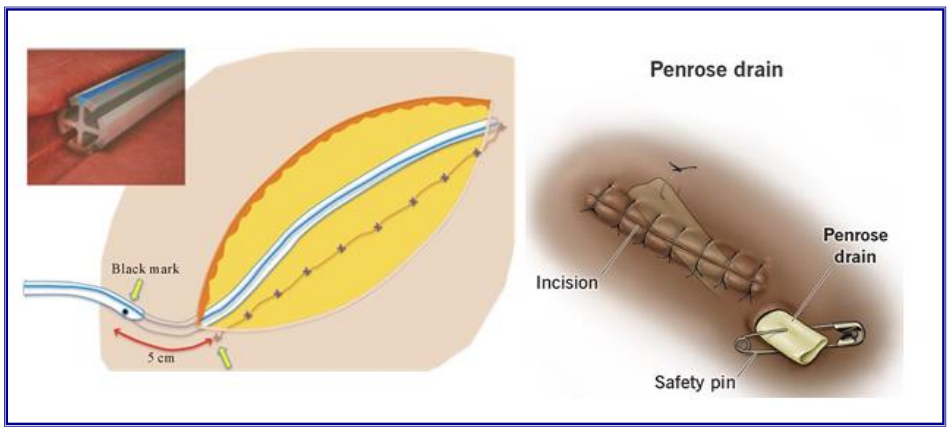

Fig. (1): Penrose drain **(9)**

2. Active Suction Drains

These drains use negative pressure (suction) to pull fluids from the surgical site. They are the main focus when discussing "suction drains."

♦ **Types of Active Suction Drains:**

1) Jackson-Pratt (JP) Drain

- Closed system with a bulb that creates suction when compressed.
- Common in abdominal, breast, and cardiac surgeries.
- Soft and flexible tubing.

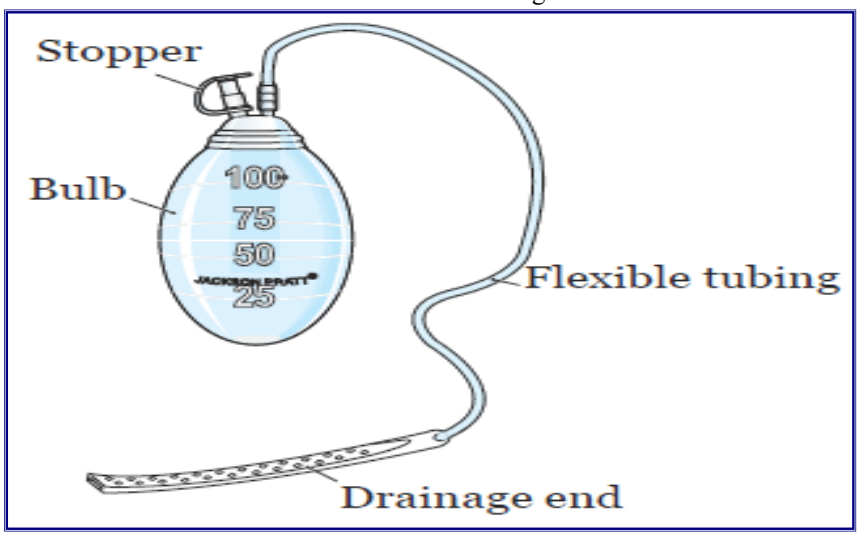

Fig. (2): Jackson-Pratt (JP) Drain **(10)**

2) Hemovac Drain

- Spring-loaded reservoir that generates stronger suction than JP drains.
- Commonly used in orthopedic and back surgeries.
- Can collect larger volumes of fluid.

Fig. (3): Hemovac Drain **(11)**

3) Blake Drain

- A type of silicone drain with internal channels.
- Often used with closed suction systems like a JP bulb.
- Less tissue irritation; used in thoracic and cardiac surgery.

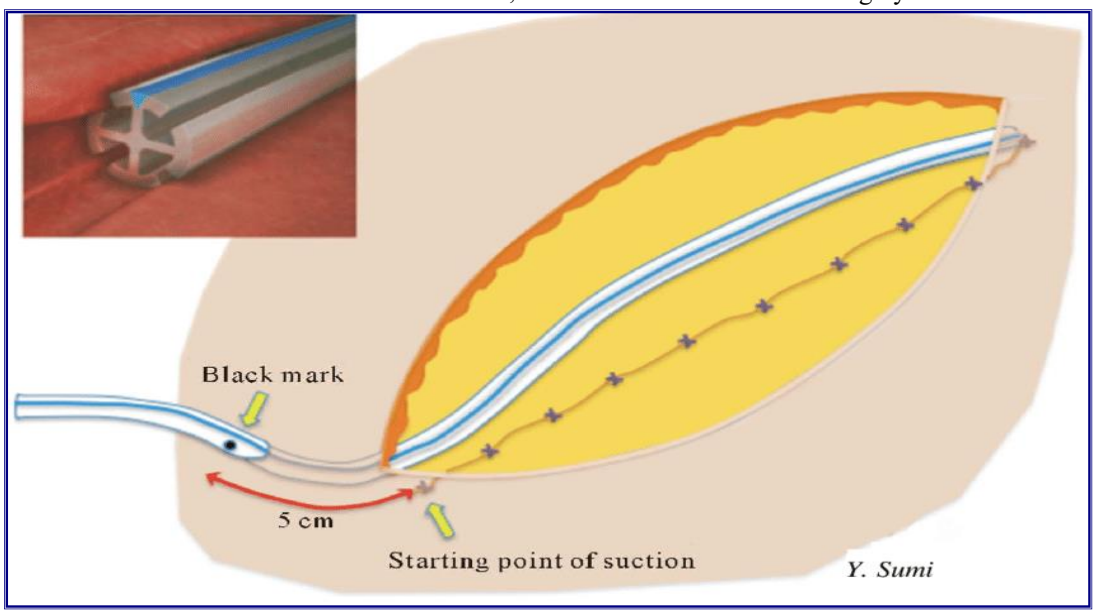

Fig. (4): Blake Drain **(9)**

4) Redon Drain

- A perforated drain connected to a vacuum container.
- Often used in European surgical settings.
- Provides continuous suction in a sterile closed system.

Fig. (5): Redon **(12)**

Vacuum-Assisted Closure (VAC) Drain

Mechanism of Action of Vacuum (NPWT)

♦ **Macrodeformation (Wound Contraction)**

- The negative pressure (suction) pulls the wound edges together.
- This **reduces wound size** and helps **approximate tissue**.

♦ **Microdeformation (Cellular Stimulation)**

- The foam dressing transmits micro-mechanical forces to the cells at the wound surface.
- This **stretches cells microscopically**, stimulating:

✓ Cell proliferation

✓ Angiogenesis (new blood vessel formation)

✓ Granulation tissue formation

♦ **Fluid Removal**

- The vacuum continuously removes **exudate, blood, and infectious material**.
- This reduces:

✓ **Edema** (**tissue** swelling)

✓ **Bacterial load**

✓ **Local inflammation**

♦ **Improved Perfusion**

- By removing interstitial fluid and decreasing pressure on small vessels, NPWT **enhances local blood flow** and oxygen delivery to tissues.

♦ **Moist Wound Environment**

- The sealed dressing maintains **a closed, moist environment**, which promotes faster epithelialization and protects the wound from contamination.

♦ **Reduced Bacterial Colonization**

- Continuous removal of wound fluid and isolation from external contaminants **reduces infection risk**. **(13)**

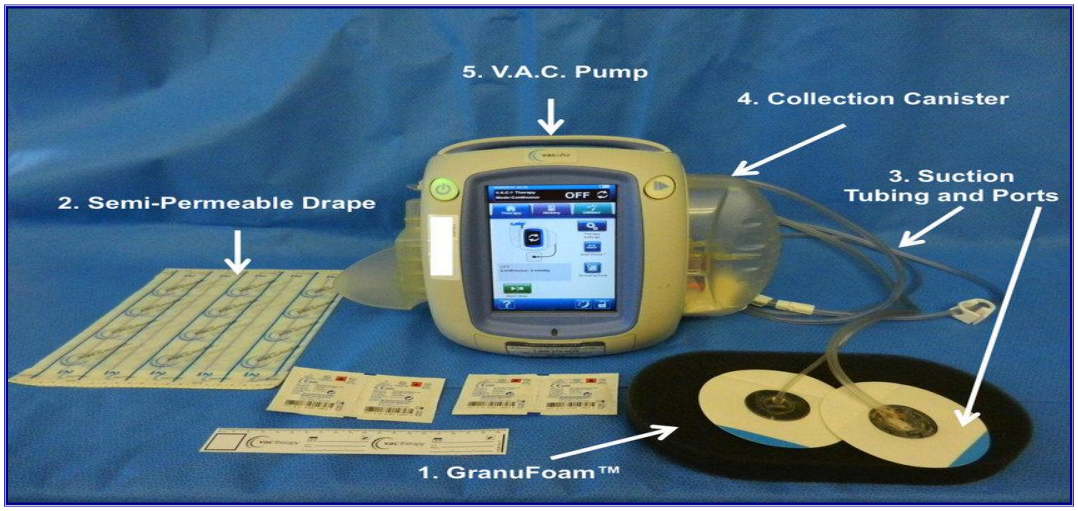

Fig. (6): Vacuum-Assisted Closure (VAC) Drain **(14)**

Complications of Subcutaneous Drains

1. Infection

- **Local infection** at the drain insertion site due to bacterial entry.
- **Retrograde infection** if the drain system is not closed or becomes contaminated.
- **Increased risk** if left in place too long or if aseptic technique is not followed **(15).**

2. Hemorrhage or Bleeding

- Drain may erode or injure small blood vessels in the subcutaneous tissue.
- Accidental trauma during insertion or removal may cause hematoma **(15)**.

3. Pain and Discomfort

- Drains can cause local irritation, especially if not properly secured.
- Movement or pressure on the drain site may cause patient discomfort **(15)**.

4. Drain Blockage or Occlusion

- Caused by clotted blood, thick fluid, or tissue debris.
- Leads to ineffective drainage and fluid accumulation (e.g., seroma or hematoma) **(15)**.

5. Skin Irritation or Breakdown

- Prolonged contact with the tubing or adhesive dressing may cause maceration or dermatitis.
- Risk of skin necrosis if excessive tension or pressure is applied **(15)**.

6. Accidental Dislodgement

- Drain may be unintentionally pulled out or loosened, especially if not properly secured.

- Can lead to premature closure of the drainage tract and fluid accumulation **(15)**.

7. Seroma or Hematoma Formation

- If the drain becomes blocked or removed too early, fluid may accumulate in the dead space.
- This can delay wound healing or increase infection risk **(15)**.

8. Prolonged Drainage

- Some patients may continue to produce excessive fluid beyond the expected period.
- Can delay wound healing and discharge from hospital **(15)**.

9. Allergic Reaction

- Some patients may react to the drain material (e.g., silicone or latex), though rare **(15)**.

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