REVIEW ARTICLE

Surgical Drains: What the Resident Needs To Know

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Abstracts

Background*: Drains continue to be an important aspect of the management of surgical patients. Its use has been contentious. However, when indicated, it is important that drainage should be practiced with prudence.*

Methods: *Publications from both local and international journals through Medline, pub med and Google search (June-August, 2007) were reviewed.*

Results: *Drains remove content of body organs, secretion of body cavities and tissue fluids such as blood, serum, lymph and other body fluid that accumulate in wound bed after surgical procedures. Therefore, reduction of pressure to surgical site as well as adjacent organs, nerves and blood vessels, enhances wound perfusion and wound healing. Reduction of pain is also achieved. However, drains are now known not to be innocuous especially when they are poorly selected, wrongly used and left in situ for too long. Essentially, passive and active drains are the most practically useful type.*

Conclusion: *Understanding the benefits and applications of surgical drains and tissue responses to constituent material is not only relevant to a practicing surgeon but would help to reduce the abuse of surgical drains.*

Key words*: Drains, surgery, application*

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Introduction

Drains are important in the management of surgical patients [1- 3]. They are appliances that act as a deliberate channel through which established or potential collection of pus, blood or body fluid egress to allow a gradual collapse and apposition of tissue[3-5]. Their use dates back to Hippocrates where metal tubes, glass tubes as well as bone [1-4] were used as passive drains. Capillary attraction in small-bore tubes which forms the basis of all passive methods was observed by Leonard da Vinci while Heaton (1889) discovered air-vent suction or active drains[1, 2]

In any surgical procedure, good haemostasis, precise and meticulous surgical technique, along with minimal tissue trauma limits the need for operative drain placement[5]. However, in some situations, placement of a drain is invaluable and is actually needed to prevent catastrophes. When indicated, it is important that a drain be used with prudence because as useful as they may be, they may cause more problems than they prevent. This review highlights a practical approach to the use and management of surgical drains.

Mechanism of Drains

A drain removes 1.contents of body organs e.g.catheterisation of urinary bladder, nasogastric tube aspiration, 2. excess secretions of body cavities such as in peritoneal and pleural cavities, 3. tissue fluids such as blood, serum, lymph and other body fluids that accumulate in the wound bed after a surgical procedure [3,6,7].This is achieved either through gravitational force or negative or positive pressures. If this fluid is allowed to accumulate, it may put pressure on the surgical site as well as adjacent organs, nerves, and blood vessels. Increased pressure causes pain and the decrease perfusion delays or impairs wound healing. The accumulated fluid may serves as a good medium for proliferation of bacteria thus increase the risk of infection. The efficiency of a drain depends on its diameter and the length, the viscosity and consistency of the drainage fluid and the force, which could be a positive or negative pressure[3].

Classification (Types) Of Drains

Drains can be classified based on various factors (TableI)

Table I Classification of drains

Basis and Factor	Types	
Mechanism	Passive	Active
Nature	Tube	Sheet/Flat
Disposition	Open	Closed
Location	Internal	External
Property	Inert	Irritant

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By far, the most practically useful classifications are those based on mechanism of action and nature of the drain material.

Passive Drains

These are drains that act by the mechanism of capillary action, gravity or the fluctuation of intra-cavity pressure [1,2,4,5.] Corrugated rubber drain (fig 1), Penrose drain (fig 2), sump drain are examples of this type. These drains are used when drainage fluid is too viscous to pass through tubular drains[5]

Active Drains

These are tube drains that are aided by active suction [8-10] which could be low continuous, low intermittent or high suction drainage[11, 12]. Jackson-Pratt drains (fig 3), Surgivac® drain, Redivac® drain (fig 4) are examples. Reliable measurement of the effluent can be done. There is decrease risk of wound infection, Minimal tissue trauma and no skin excoriation. However, regular activation of reservoir is often required.

Table II: The major differences between active and passive drains

	Active	Passive
Function	Works by active suction	Depends on pressure differentials
Pressure gradient	Negative pressure(low, moderate, high)	Positive pressure
Drain exit site	Dependent position not necessary	Dependent position necessary for best function
Drain site dressing	Minimal or not required	Bulky to absorb fluid output
Measurement of effluent	Reliable and accurate	Difficult to quantify
Fluid re-collection	Unlikely because negative pressure improves tissue apposition	Likely because of limited effect on the dead space
Retrograde infection	Lower incidence especially with close suction system	High incidence especially with open system
Obstruction of drain	More common due to smaller caliber	Less common
Radiographic studies	Easy to perform	Difficult except in special circumstances like T-tube and Nasogastric tube
Pressure necrosis	High incidence	Low incidence

Tube Drains

These are hollow tubes of varying materials brought out through a body orifice or stab wound. When they are connected to a bag they become closed but when left alone they remain open drains [1-5, 13](fig 5). Multiple holes on the end are necessary and essential in case one hole becomes blocked.

Sheet Drains

These are drains made in sheet of gutters or parallel tubes through which fluid passes [3-5] (fig 1). Corrugated rubber drain, which the fluid tracks through the gutters to the surface, is one commonly used example of this type of drain. Another example is Yeates drain (a sheet formed from parallel plastic tubes) in which fluid passes through the tubes; once these have filled, it tends to track along side of the drain.

Flat Drains

These are drains that are made flat with 3/4 or full length multiple perforations (fig 6) which can be connected to a tubing system, thus, convert it to a close system or left opened. The inner wall of the flat segment usually has internal “ribs” to prevent it from collapsing or kinking. They are often used for various surgeries, including plastic and reconstructive surgery.

Open Drains

These drains empty directly to the exterior into the overlying wound dressings or stoma bag. Corrugated rubber drain, Penrose, gauze wick drain (fig 7) and glove finger drain (fig 8) are examples of this type of drain. They are mostly used in superficial wounds and cavities. Drained fluid collects in gauze pad or stoma bag which can easily be changed. It is simple and easy to apply. However, it is often difficult to measure the effluent. High rate of wound infection, trauma to the skin from repeated changing of dressings, skin excoriation and erythema due to irritation by the effluent has been noted [6,7].

Closed Drains

These are hollow tubes of varying materials (see fig 9) brought out through a body orifice or stab wound and are connected to closed system of sterile drainage bag [8, 9]. Under water seal drainage system is an example. This drain is mostly used in deep cavities[8]. The risk of skin excoriations and surgical wound infection is less. Effluent can easily be collected and measured. However, reflux of the contents of a contaminated reservoir has been noted [6, 8].

External Drains

These are drains that are brought out through the body wall to the exterior[4]. The fluid discharge is channeled from the deepest part of the cavity to the exterior. This can be passive or active drain.

Internal Drains

These are drains that are placed internally within luminal organs to create a route or to connect two luminal organs. They divert retained fluid from primary drainage site or area to a distal body passage or cavity in order to bypass an obstruction. They are used in neurosurgery for internal drainage of hydrocephalus (ventriculo- jugular shunt, ventriculo-atrial shunt, ventriculo-peritoneal shunt); in gastrointestinal surgery where souther tube, Celestine tube and mousseau-barbun tube could be used to palliate malignant obstruction of the esophagus. Internal drains are used as stents in urethral and ureteric strictures too.

Irritant Drains

These are drains made of materials that are irritative to the tissue and so are capable of exciting fibrous tissue response leading to fibrosis and track formation[5]. Examples are latex, plastic and rubber drains.

Inert Drains

This group of drains is non- irritative to the tissue and so ideally do not provoke tissue fibrosis. Examples include polyvinyl chloride (PVC), silastic and silicone drains.

Fig 1 Sheet of corrugated rubber drain

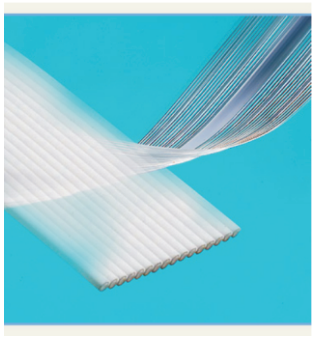

Fig 2 Penrose drain

Fig 3 Jackson-Pratt drain

Fig 4 Redivac drain

Fig 5 Tube drain (open)

Fig 6 Flat drain

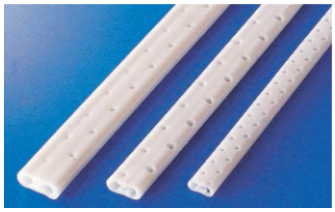

Fig 7 Gauze wick drain

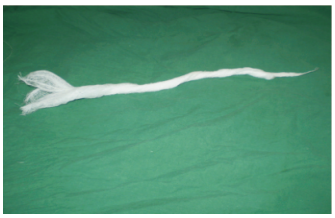

Fig 8 Glove finger drain

Fig 9 Close Tube drain

Fig 10 Close tube (small size) facial/ plastic wounds

Ideal Drain

1. A drain should be firm, not too rigid, so as to remain in its intended place[3].It should not be too soft either as it may twist or kink or become blocked [3,5].
2. Smooth so as not to allow fibrin to adhere on to it and to allow easy removal after use.
3. Should be a material that will be resistant to decomposition or disintegration so as to avoid leaving foreign bodies behind
4. Drain should be wide and patent enough to prevent easy blockage by effluents
5. It should be non electrolytic, non carcinogenic and non-thrombogenic when used in vascular surgery

It is however pertinent to note that an ideal drain does not exist in practice but effort should be made to choose the most appropriate in every situation. It is hoped that advances in technology should help in producing an ideal drain in future.

The Purpose of a Drain

Therapeutic:-A drain permits the exit of gases and liquid and could be used to treat conditions like hydrocephalus, urinary retention, and abscess cavity [3,14].

Palliation: - It could be used as a palliative measure to bypass a luminal obstruction[3]

Diagnostic: - T-tube cholangiogram as a post cholecystectomy diagnosis of retained stones in the common bile duct[15].

Prophylactic: - To prevent post operative complication that could arise from fluid accumulation in a wound cavity [16,17].

Monitoring: - For instance, monitoring progress by Naso-gastric tube in a patient with upper gastrointestinal bleeding, monitoring of urinary output [5,7].

Access route: - For percutaneuos therapy[18], e.g. useful in percutaneous nephrolithotomy.

Indications for Surgical Drains

Therapeutic

Tension pneumothorax
Pleural fluid
Abscess cavity
Seroma
Acute urinary retension
Acute suppurative arthritis
Infected cyst

Palliative

Advanced Ca esophagus
Hydrocephalus

Diagnostic

Biliary fistula
T-tube cholangiogram for retained gall stones in common bile duct

Prophylactic

Cardiothoracic procedures
Esophageal resection
Duodenal stump following polya gastrectomy
Elevation of extensive skin flap
Post thyroidectomy
Thoracotomy
Uncomplicated cholecystectomy
Splenectomy
Pancreatectomy
Patient on PPV post chest trauma

Monitoring

Gastrointestinal bleeding
Urethral catheterizations

Dual indications (diagnostic + therapeutic)

Biliary fistula
Gastrointestinal

Care of Surgical Drains

Intra- operative

Drains should be placed such that they take the safest, shortest route possible[3]. They should reach the deepest, most dependent part of the cavity or wound. Bring out external drains through a stab wound, and not from the main wound so as to minimize the incidence of wound infection[19].Tubing should remain free of kinks, debris and clots so as to enhance free drainage[5].The drain should be secured well so as to avoid falling off or its migration into the cavity or erosion of surrounding tissue [20,21].Drain should be lower than the incision at all times[19].

Securing a surgical drain

Ensure the drain is secured and the system is intact to prevent dislodgement and infection or irritation of the surrounding skin [21,22]. Drains have been secured using various techniques and materials [20,21,22,23]. The commonly used technique includes Roman Garter technique[23] which uses silk to secure the drain. This method relies on silk creating a sufficient friction around the drain to secure it. However, when the technique is

poorly performed or the silk becomes wet, its friction may be lost and the drain may become loose. Other techniques include the use of nylon suture, safety pin, drain clip, adhesives, Tie-lok™ [20,22,24] which is also known to be associated with some limitations.

Post operative care of a surgical drain

1. The post-operative care of a drain depends on the type, purpose and location of the drain [25, 26]. However, generally speaking, the skin around all insertion sites must be kept clean and dry to prevent infection and skin irritation. Meticulous skin care and aseptic technique must be observed during application and change of dressing over drains[26]. Gauze dressings are used around and over drainage tubes, especially passive drains, to protect the tube, absorb some amount of drainage, assist with the stabilization of the tube and help to protect from external contamination.
2. A drain dressing should be inexpensive, should be easy to apply and removed without dislodging the drain[25]. It should be absorbent and ensure great comfort to the patient.
3. An accurate measurement and record keeping of drainage output must be ensured.Monitor changes in character or volume of fluid; identify any complication resulting in leaking fluid as fast as possible.
4. Replace fluid loss through drain by additional intravenous fluids.
5. Drain container or reservoir should be emptied at least once a day.
6. Regular activation of the reservoir of active drains must be ensured.

When to discontinue a surgical drain

Generally, drains should be removed once the drainage has stopped, its output has become <25-50ml/day, or the drain has stopped serving the desired function.

The character and viscosity of the drainage fluid are occasionally considered before drains are removed such as an initial haemorrhagic effluent becoming clear fluid.

Some drains, particularly open (passive) e.g. corrugated or flat should be "shortened" by withdrawing approximately 2cm/day thus allowing gradual healing of the site from it deepest part outwardly. This is very useful especially when a drain is placed in an abscess cavity, wound bed, and skin flaps where apposition of tissue is required.

Drains that were intended to protect postoperative sites, anastomotic sites and require forming a tract should be delayed and removed when intended desire is achieved.

Complications and Their Prevention

Tissue reaction particularly when irritant drains are used may be enormous and detrimental. Careful selection and use of non-irritant drains should prevent this complication.

Source of contamination the fact that a drain is a conduit allows opposite traffic within it, thus, increasing the possibility of surgical site infection [3, 5]. However, strict aseptic and proper drain care, if observed will limit rate of surgical site infection. Occasionally, antibiotic cover may be necessary particularly in susceptible drains.

Delayed return of function: - limitation of movement in patients with surgical drain [3] may cause a delayed return of function. Early mobilization is paramount in this case.

Retained foreign body: - This may be possible when the drain disintegrates following enzymatic action, trauma or undue traction. Proper selection of drain, adequate care and prompt removal after use will suffice.

Tissue necrosis from pressure of very hard or stiff drain may be prevented by the use of soft drain.

Bowel herniation: - May occur through the weak drain site, particularly when it was complicated by infection [3, 5, 6]. Proper drain insertion technique and meticulous care will prevent this complication. Occasionally, the drain site may need to be closed by one or 2 sutures to prevent herniation.

Haemorrhage: - Occurs during insertion or from repeated injury of the surrounding tissue, especially during mobilization and change of dressing. A stiff drain may also precipitate bleeding if it erodes into a large vessel. If this continuous, the drain should should be removed under vision and haemostasis secured.

Prolonged healing time A drain is a foreign body therefore its presence in the tissue may delay or prolonged wound healing. Every drain must be removed when it's no longer needed.

Drain entrapment and loss: - The drain may become entrapped when fibrous adhesions develop around it[19].

Fluid, electrolytes and protein loss: - This may occur, particularly when the output is high.

Migration of the drain: - A drain may migrate into the tissue or fall off [3, 19]. Proper anchoring and care should prevent it from migrating. Radiologic investigations may

occasionally be needed to locate internally migrated drains.

Erosion of viscera: - Particularly drains that are placed within the peritoneal cavity without a well defined abscess cavity. This should be avoided as much as possible.

Controversies

The use of drain in surgical practice has been contentious over the years. The arguments in support of their use include the fact that drains remove accumulated fluid, which is a potential source of infection; they guard against further collections; they may allow early detection of anastomotic leaks or haemorrhage; leave a tract for percutaneous therapy and for potential collection to drain following removal. While those who argue against their use assert that, the presence of drains in the body increases the risk of infection; increases hospital stay; delay tissue healing; tissue damage may be caused by mechanical pressure or suction and drains may actually induce an anastomotic leak.

The old paradigm that says "When in doubt, drain" and "it is better to have and not need it than to need it and not have it" may no longer be tenable. These concepts apparently are based on the assumption that there are no complications related to the use of drains. Drains are now known not to be innocuous when left in situ. To drain or not, which drain and for how long all remain unanswered questions, but the diversity of answers suggests that no single policy is necessarily correct. Every situation must be considered on its own merit, and the most appropriate drainage method and material carefully selected. This policy is more practicable than a dogmatic approach.

Recent Advances

Several attempts have been made to improve the functionality and reduce significantly, complications associated with the use of drains in surgery. Thus, over the few years, major advances in surgical drains have been recorded in the following areas.

1. Drains with one way entry valves to secure against reflux of contaminated fluid from reservoir have now been developed.
2. Bottom drainage ports placed at the opposite end of the reservoir from entrance port, to prevent contamination, and ease the emptying process.
3. Soft, supple and low profile drains to enhance easy positioning and conformation to anatomical curvatures.
4. Multiple sump lumens to create high internal flow rates that accelerate fluid removal without applying excessive or traumatic suction to delicate tissues.
5. Dual lumen to allow introduction of saline, anaesthetic or use as a sump
6. Rotating garment clips to bring about convenience to care giver and increase mobility to the patient have been developed.
7. The use of variable sizes of drains with special specifications (see fig.10) to meet specialist demands is expanding rapidly.
8. Non-clogging silicone formulation has solved the problem of clot build-up. The high flow- through accelerates fluid movement without excessive suction.
9. Anti-thrombogenic coating of drains (both internally and externally) provides surfaces with lowest coefficient of friction. It makes insertion and removal easier and reduces the problem of adjacent tissue trauma or erosion.
10. Further efforts are in place to provide surgeons the needed specificity, functionality and greater flexibility in their selection of drain systems. The drainage need of all surgical specialties is intended to be met by offering the widest range of sizes, options and specialty specific features.

Practical Tips

A drain is said to be abused when it is used for the wrong indication.

Prolonged use of drain, long after it is due for removal has no additional advantage.

Premature removal of a drain before it has completed its function increases morbidity, and waste of resources.

Wrong selection of materials for an indication may be counterproductive.

Wrong placement of a drain, makes it ineffective.

Poorly secured drain may dislodge.

The use of much narrowed lumen tube drains, is often ineffective and can easily block.

The use of drain to provide a false sense of security or as a substitute for adequate haemostasis is detrimental, and surgically unacceptable.

Failure to protect the drain from contamination by feaces, urine, dirts e.t.c increases the incidence of surgical site infection

Failure to protect the drain from kinking, knotting or blockage may lead to disaster.

Patient lying on top of drain with intent or not is counterproductive

External drain should be brought through a stab wound and not through the main wound

A surgical drain placement should be timely and remain functional to maximize its effect.

Conclusion

There are a variety of factors which militate against formulating rigid guidelines for the use of surgical drains but surgeons should understand the benefits and application of drains and the tissue responses to the constituent material so as to prevent some of the commonly seen complications. Three questions are essential and serve as a basic frame work which must be considered when deciding on the value of surgical drains. 1. What purpose would a drain serve if placed? 2. What type of drains should be used? 3. How long should the drain be left in place? Once these questions are carefully and adequately answered each time a drain is used, the effectiveness and advantages can be maximized with minimal problems.

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