IMPROVISING A SURGICAL DRAIN WITH AN INFUSION GIVING SET AND AN EMPTY SALINE CONTAINER: AN IMPROVISED SURGICAL TECHNOLOGY CASE REPORT

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Abstract

Background: Improvisation is key to surmounting challenges of unavailability and prohibitive cost of surgical staff, stuff, space, and systems in Low- and Middle-Income Country contexts. We describe a step-by-step method for construction of an improvised surgical drain which has been used at our institution following thyroidectomies and mastectomies requiring drainage in a setting of resource constraints for over 20 years.

Patients: The drain has found use in surgical wound drainage following thyroidectomy, mastectomy, and laparotomy for patients with indications for drainage.

Intervention: In this surgical technology case report, we describe the 7-step process for fashioning and deploying this low-cost, low negative-pressure, closed tube surgical drain from an empty 500 mL normal saline collapsible plastic container, and an intravenous fluid giving set. The drain generates a calculated maximum opening negative pressure of 15.4 kPa calculated by Bernoulli equation and costs about 1.1 USD.

Conclusion: The technological simplicity of this low-cost improvised, negative pressure, closed tube drain for thyroid, breast, and abdominal surgeries in low resource settings constructed from a 500 mL infusion bag and an intravenous fluid giving set is apparent. The drain's bio-mechanical efficiency and cost effectiveness must be validated against standard custom-made drains. Some randomised control studies are being carried out to that effect.

Keywords: Improvised, surgical drain, Low resource, Case report, Low-cost

Introduction

A drain is a device that acts as a deliberate channel through which established or potential collections (pus, blood, air, or body fluids) egress to allow gradual collapse, apposition of tissue, and reduction in cavity pressure.[1] Currently, a gamut of eponymous and commercial custom-made drains exist.[2] Despite age-long controversies, the selective or routine use of drains in thyroid, breast, abdominal, orthopaedic, and plastic surgery is common practice. Indications for applying surgical drains could be therapeutic, diagnostic, prophylactic, or monitoring; however, the placement of a drain is not a replacement for good surgical technique or adequate haemostasis.[1] Improvisation is critical to surgical practice in sub-Saharan Africa. A teeming populace juxtaposed with relatively poor health-care facilities and funding challenges have made it imperative to look for alternative local sources of essential surgical equipment.[3] Improvisation is driven by financial factors like high out-of-pocket expenditure, resulting from low insurance penetration, and heightened risk of catastrophic expenditure.[3] The cost of surgical devices like drains contribute to this narrative. Surgical practitioners must arrive at creative solutions generated using locally accessible alternatives in limited resource settings.[3] We describe an improvised, negative pressure, closed tube drain (fashioned using an infusion giving set and a semi-rigid infusion bag) that has been in use at our institution for over two decades. It has found use in wound drainage following thyroidectomy, mastectomy, and laparotomy. The utility of such a drain has previously been mentioned in a letter to the editor,[4] but a detailed step-by-step process of construction for this drain has, however, to the best of our knowledge, not been previously described in literature.

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Materials needed for the construction of the improvised negative pressure drain is shown in Table 1.

Table 1: Materials needed

S/N	Materials for Drain Construction	Comment
1.	1 empty 500 mL Normal Saline[a] collapsible plastic bottle	Uncontaminated[b,c]
2.	1 intravenous fluid infusion giving set	New, do not reuse
3.	1 pair stitch-cutting scissors	
4.	1 curved artery forceps (curved hemostat)	
5.	1 needle driver (needle holder)	
6.	Vicryl® 2-0 suture	Vicryl® 3-0 is an alternative
7.	1 Toothed dissecting forceps	

a. A normal saline bottle is preferred, as dextrose containing fluid bags may theoretically encourage the growth of glucophagic microorganisms in the residual fluid and encourage wound infection.

b. Precautions to be taken to avoid contamination of the used intravenous fluid container include avoiding the use of fluid containers punctured with hypodermic needles and ensuring seamless, immediate transfer from the intravenous fluid giving set to the improvised drain without handling the punctured end.

c. The use of visibly soiled or leaking fluid bags is avoided.

Method

1. First, the distal portion of the infusion giving set is shortened from the patient end, leaving about a 30 cm length distal to the drip chamber incorporating the control valve (Figure 1, 2).
2. An even longitudinal slit is then made from the distal end 10-15 cm long using stitch scissors with one blade insinuated into the giving set lumen and the other outside the lumen (Figure 3). The slit end was the intra-wound portion. The creation of multiple fenestrations along the distal 8 cm of the tube at 2 cm intervals is an alternative to slitting.
3. A medium-sized blunt artery forceps is used to create a passage from the space to be drained, through the overlying tissue from in to out. These forceps is used to grasp the intra-wound portion of the prepared improvised drain. This is then drawn into the anatomical cavity and the drain is positioned appropriately.
4. The surgeon ensures that the proximal end of the slit or the last fenestration is at least 2 cm from the skin. The wound is then closed over the drain as appropriate.
5. A modified Roman garter technique is then used to anchor the improvised drain. This is achieved by passing Vicryl® 2-0 suture through the skin beneath the exit of the drain and winding the two ends of the suture in opposite directions over the drain to encircle and secure it like a sandal lace.
6. After securing the drain to the skin with suture, an empty fluid bag is collapsed by serial folding from the base to produce a visual concertina-like effect thus generating a negative pressure.
7. The bag end of the giving set is then inserted into the empty collapsed fluid bag to produce a closed, negative pressure system (Figures 4, 5).
8. Where the plastic reservoir loses its recoil potential, the entire system drainage slows or stops, and the drain becomes non-functional. Attention must be placed on adequate intermittent recharge depending on collection, daily monitoring of functionality, and replacement of any deficient, leaking, or non-compliant reservoirs and other standardized care of drains.[1]

Discussion

We have described a simple but effective improvised drain fashioned from readily available materials that can be found in almost any healthcare facility. Several improvised drains have been used in place of custom-made drains on account of cost and availability. Ezeome and Adebamowo described a simple, closed drain fashioned out of a feeding tube with multiple fenestrations along the intra-wound section connected to a urine drainage bag.[5] Esezobor and Okunmayin described a syringe and feeding tube or drip system as an effective closed suction drain and a low-cost alternative to conventional vacuum drains in rural surgical practice.[6] Ogirima described a recycled Redivac® or Hemovac® system using the perforated end of a sterile intravenous line in place of the used manufacturer's tube and introducer.[7] Igwe and colleagues described the spring active drain of Adotey fashioned using wire from a condemned umbrella, pliers, a urine bag tube, infusion giving set, and a 50 or 60 ml syringe.[8] Adeleye *et al.* described the use of a urine bag as a low-cost, passive, single unit wound drain post craniotomy.[9]

Our improvised drain is arguably one of the most affordable improvised negative pressure devices described. A single component of the improvised spring active drain described by Igwe *et al.* costs between 2.94 USD and 5.88 USD.[9] In contrast, as at the time of writing, a giving set in our clinical setting costs 0.13 USD while an infusion bag costs 0.97 USD, bringing the total direct costs of this drain to about 1.1 USD (400 NGN). Unlike Ogirima's or Adotey's improvised drains, no component of this drain incurs additional costs of sterilisation.[8,9] Other less expensive improvised drains, like those described by Ezeome *et al.*, FyneFace-Ogan *et al.*, and Adeleye *et al.*, are passive and cannot supply negative pressure.[6,10,11] The large potential volume of the receptacle of this drain (500 ml) is an added advantage over Esezobor and Okunmayin's syringe suction drain (2 ml) and Adotey's improvised drain (50 ml).[7,9]

Several characteristics of this drain approximate that of the theoretical ideal.[1] It is neither rigid not too soft, it is smooth, resistant to early decomposition or disintegration, and non-electrogenic.[1] This drain generates a calculated maximum opening negative pressure of 15.4 kPa calculated by Bernoulli equation with the assumption that there will be no loss from the system and compares well with the opening pressure of the 4.67 mm internal diameter 14 French Romovac® drain (14.66 kPa).[10]

The authors have varying preferences between slitting and fenestrating the improvised tube drain. Fenestration of the giving set provides multiple sites for fluid to egress into the drainage tube and mimics the customised Redivac drain design more closely. However, we have seen that the process of creating multiple fenestrations may result in accidental transection of the tube at fenestration sites. A further disadvantage of perforation over slitting is that perforated apertures tend to structurally weaken the drain.[11] In the process of drain removal, jagged fenestrations may snag on tissue, vessels or clots resulting in iatrogenic injury and resultant haemorrhage, or fortuitous drain amputation at the site of a large fenestration. Slitting mimics a fluted drain, provides an increased drain body cross sectional area, and eliminates "stress raisers" (weak points) along the drainage tube.[11] Also, inadvertent functional variability may be created by varying the number of fenestrations and their placements. Without precision instruments, fenestrations will be of varying shapes, diameters, and sizes and at different distances from each other on different drains even when the constructor is deliberate. This brings more pronounced variability to functional device assessments in randomised control trials. A prospective study comparing perforate and slit improvised drains may be necessary in the future.

Preliminary results of a randomised control trial comparing the use of this drain with a standard custom-made closed tube drain in thyroidectomy suggests equivalent efficacy and significant savings in direct costs. A randomised control trial describing its use in draining mastectomy wounds is also underway.

Conclusion

Surgical intervention need not be delayed on account of unavailability or prohibitive cost of custom-made drains in low resource settings. The technological simplicity of this low-cost improvised, negative pressure, closed tube drain for thyroid, breast, and abdominal surgery in low resource settings constructed from a 500 ml infusion bag and an intravenous fluid giving set is apparent. The materials utilised are affordable and available in virtually every clinical setting.

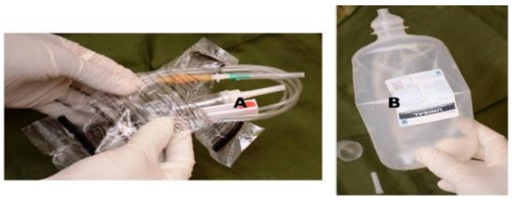

Figure 1: Materials needed for fashioning the improvised drain. **(a)** Unused sterile intravenous fluid giving set. **(b)** Collapsible, plastic 500 ml intravenous fluid container.

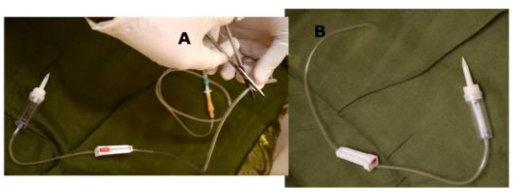

Figure 2: (a) Shortening the giving set by cutting off the patient end. **(b)** The resultant shortened tube.

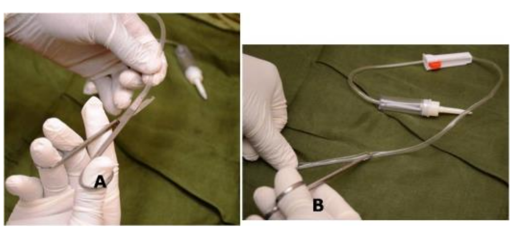

Figure 3: (a) Stitch scissors positioned to slit the lumen. **(b)** Slitting the lumen.

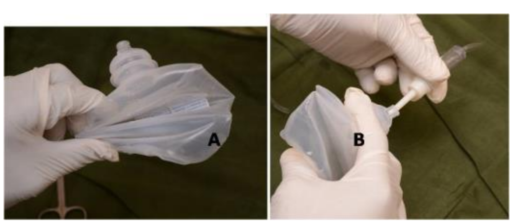

Figure 4: (a) Charging the drain reservoir for negative pressure. **(b)** Completing the closed, negative pressure system by connecting the reservoir to the giving set**.**

Figure 5: Patient in immediate postoperative period with improvised drain in-situ

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