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Early outcome of use of active versus closed passive wound drains in open reduction and internal fixation (ORIF) of lower extremity fractures

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Abstract
Drains are required in areas where extensive dissection has been performed in a closed space as seen in the case of open reduction and internal fixation (ORIF) of lower extremity fractures which might be acute fractures, non-union and malunion. In ORIF, reduction and fixation are achieved using open technique requiring extensive surgical approaches and soft tissue dissection leading to haematoma/seroma formation and need for wound drain. These wound drains are not without outcome. Hence, the need for this study; "Early outcome of use of active versus closed passive wound drains in ORIF of lower extremity fractures".
Objective: Evaluation of early outcome of use of active versus closed passive wound drains in ORIF of lower extremity fractures. Secondly, to compare the incidence of wound infection, wound dehiscence, postoperative pain and cost between active versus closed passive wound drains.
Methods: This study was a prospective randomized comparative study for 48 patients with closed fractures of lower extremities undergoing ORIF. Patients were randomized into two groups- group A and B. Group A had ORIF with insertion of Emvac-active wound drain while group B had ORIF with insertion of urine bag-closed passive wound drains. A structured proforma was used to collect relevant data from the accident and emergency, clinic, intraoperatively, postoperatively and follow up. Pain was assessed postoperatively using Numeric Rating Scale (NRS) while surgical site infection was assessed using Southampton grading. Drain was removed 48 hours after surgery or once its effluent has stopped draining.
Results: The mean age of participants was 45.53 ± 18.23 with a range of 19-76 years. There was no statistically significant difference seen in mean age, postoperative surgical site infection using Southampton grading from 3rd postoperative day to 28th day between the 2 studied groups. There was also no statistically significant difference between group A and group B in postoperative pain using NRS from 12 hours to 14 days postoperatively. There was also no significant difference in degree of wound dehiscence, average quantity of effluent and soaking of wound dressing between the 2 groups postoperatively. However, there was highly statistically significant difference with regards to the average cost of wound drain alone between the active versus closed passive wound drain group with a t- test of 39.890 and a p value of < 0.001.
Conclusion: It can be concluded from this study that there was no statistically significant difference in incidence of wound infection, wound dehiscence, quantity of effluent, soaking of wound dressing, length of hospital stay and postoperative pain. But there was statistically significant difference in the cost of wound drain alone between the two studied groups.

Keywords: Early outcome, active drain, passive wound drain, open reduction and internal fixation, lower limb fractures

Introduction
Drains are appliances that function as deliberate channels used to evacuate established or potential collection of blood, pus or air [1]. The qualities of ideal drain includes firm, not too rigid, not too soft, resistant to decomposition or disintegration, wide and patent, non- irritant, non-carcinogenic and non-thrombogenic [1]. In surgical practice, drain could be used for therapeutic, palliative, prophylactic purpose. It could also be used for diagnosis or monitoring the output and progress of wound healing [1, 2].

The function of a drain is to remove unwanted fluid from a wound or body cavity thereby preventing accumulation. The appropriate use of drain can accelerate healing process [2]. Dead space is an abnormal space within a wound due to disruption of interstitial connective tissues into which blood or serum accumulates [3]. The fluid accumulation in this space is a great medium for bacterial growth [3]. Tait's famous dictum "when in doubt, drain" is still relevant and helpful, this requires the surgeon when in doubt to drain [4]. When, ever there are surgically created raw areas, there is always tissue exudation of body fluid. Even if haemostasis is adequately secured, there still remains minor ooze of blood and tissue exudates from raw areas. Initially, this body fluid may be sterile and may contain natural antibacterial substance such as opsonins, immunoglobulin and phagocytic cells [5]. However, the concentration of antibacterial substance decreases over a period of time exposing the tissue to bacterial growth [5]. Open reduction and internal fixation (ORIF) of acute traumatic fractures, non -union and malunion of long bone fracture presents the condition for the use of drain. In situations where haemostasis is sometimes difficult to achieve and a postoperative haematoma is likely to occur, wound drain is inserted to drain the effluent [6]. When a Wound drain is used, it is left in place until the effluent stops draining or the output is equal or close to the physiological output of the cavity being drained. Once effluent is no longer draining, wound drain could be safely removed [1, 4]. Classification of wound drains is based on various factors [1]. (i) mechanism of action e.g. Active or Passive wound drain [1], (ii) nature e.g. tube or sheet drain, (iii) disposition e.g. open or closed drain and (iv) location e.g. internal or external drain [1].

Drains could be broadly classified into two types based on communication with the external environment into closed and open wound drains. Closed drain connected to a container with or without suction [1, 5]. This form of drainage avoids spillage and soiling of dressing and hence minimizing the risk of cross infection. Open drains are mostly passive in nature. These drains inevitably increase the risk of contamination because they drain into the surface dressing. Such drains are messy and provide conduit for bacterial access into the wound [1, 3].

Drains can cause a number of complications which they are designed to prevent. The presence of a drain does not guarantee that an abscess or other collection will not reform. Foreign body reactions can isolate a drain from adjacent tissues, preventing pus, blood or other fluid from accessing the lumen. Drains and the tissues they traverse can be colonized by microorganisms from exogenous sources. Open drains increase risk of infection [7]. Drains could be detached and retracted into the body cavity. Open drains can cause skin excoriations etc. Active drains are closed tube drains aided by active suction which could be low continuous, low intermittent or high suction drainage. Various types are available such as Jackson-Pratt drains, Redivac drain, Surgivac drain etc. Advantages of active drains are (i) reliable measurement of effluent (ii) decrease risk of wound infection(iii) minimal tissue trauma(iv) no skin excoriation (v) it can also be used in areas that are difficult to bandage [7]. (vi) It also has ability to collapse dead space more than the passive drain [8]. However, it requires regular activation of reservoir.

Passive drains are drains that act by capillary action, gravity or fluctuation of intra-cavity pressure. They could be open or closed e.g. corrugated rubber drain, Penrose drain, urine bag [3, 5, 7] etc. Open drains empty directly to the exterior into the overlying wound dressings or stoma bag. E.g. Penrose drain, Gauze wick drain. Open drains are simple and easy to apply, but cause high rate of wound infection and skin excoriations [7]. Closed drains are hollow tubes of varying materials brought out through a body orifice or stab wound and are connected to closed system of sterile drainage e.g. under water seal drainage system. Risk of surgical wound infections and excoriations are less [7].

Despite, the recent advances made in the use of wound drain in surgery many controversies are still surrounding the use of wound drains in surgery [1]. To drain or not to drain and which wound drain has remained unanswered[1] Moreover, the cost of active wound drain is ten to twenty times the cost closed passive wound drain. Thus adding to the overall cost of patient's management especially developing countries where there is limited health insurance and patients pay for their health management out of their pockets. Drains are commonly used in AE-FUTHA during open reduction and internal fixation (ORIF) of lower extremity fractures which is one of the common procedure in the centre [9]. But there is no study in this Centre that has compared the early outcome of use of active versus closed passive wound drain in ORIF of lower extremity fractures. There is no clear definition of early outcome in the use of active versus closed passive wound found in the literature. However, from the definition of early postoperative recovery phase, early postoperative health related quality of life and early and early surgical site infection which occur within thirty (30) days after surgery [10, 12]. Therefore, the early outcome of use of active versus closed passive wound drains in ORIF of lower extremity fractures could be defined as any surgical outcome occurring within thirty (30) days of ORIF of the lower extremity fractures [10, 12]. While any outcome occurring after thirty (30) days of ORIF of lower extremity fractures is late outcome [10, 12].

Materials and Method

This was a prospective study which was used to evaluate the early outcome of the use of active versus close passive wound drain in the ORIF of lower extremity fractures. It was carried out over a 12-month period at Alex Ekwueme Federal University Teaching Hospital, Abakaliki (AE-FUTHA), a tertiary institution located in Abakaliki, the Ebonyi state capital of South Eastern Nigeria. Patients of both sexes aged from 18 years and above who presented to the hospital with acute traumatic fractures, fracture non-union and mal-union of lower extremities requiring ORIF were included while any patient with uncontrolled comorbidities such as diabetes mellitus, hypertension, bleeding disorders, blood dyscrasias, sickle cell disease and immunocompromised patients were excluded. This study was carried out on all consenting patients who presented to AE-FUTHA with fractures of lower extremities requiring ORIF with a written consent obtained before surgery. Patients who decline consent were not included in this study and this did not affect their medical care.

Ethical approval was obtained from the Ethics Committee of the hospital (AE-FUTHA/REC/VOL 3/2021/164).

Patients who met the inclusion criteria were randomized into two groups: Test and control (A and B). The test group A had active drain while the control group B had closed passive wound drain. Balloting was by simple random technique at booking in the ward. The patient picked their groups until sample size is completed. The cost of the wound drain Emvac drains (₦) was - (3500.00 x 4) + (3800.00 x 6) + (4000.00 x 6) + (4500.00 x 5) + (5000.00 x 3), while Urine bags (₦) was - (175.00 x 4) + (180.00 x 6) + (200.00 x 8) + (220.00 x 6). These figures was used to calculate the average cost of wound drains alone.

Data was collected with a structured proforma. This proforma have both open and closed sections and were filled at booking, immediate postoperative (within 12 hours postoperatively) and follow up.

Emvac wound drain is an example of active wound drain and was used for group A. it was manufactured by Sterimed Medical Devices Pvt. Ltd, Plot No.211A, Sector-16, HSIIDC, 38 Km Stone, Delhi, Rohtak Highway, Bahadurgarrh, Haryana, India and marketed by Emzor Hesco Limited. Urine bag is an example of closed passive drain. It was used for group B. it was manufactured by Huaian Angel Medical Instruments CO.LTD 19 East Zhuhai Road, Huaian, Jiangsu, China and marketed by Agary Pharmaceutical Limited.

Outcome Measures

The outcome measures included, incidence of wound infection, postoperative pain, wound dehiscence, length of hospital stay and cost of wound drain alone.

Southampton Score

This was used to assess postoperative incidence of surgical site infection. The Score was designed originally by Bailey *et al.* in 1992 to assess hernia wounds[13]. Wounds were graded according to extent and complications[13]:

Grade 0: Normal healing

Grade I: Normal healing with erythema

a) Some bruising
b) Considerable bruising
c) Mild erythema

Grade II- Erythema plus other signs of inflammation

a) At 1 point
b) Around sutures
c) Along wound
d) Around wound

Grade III: Clear or haemoserous discharge

a) At 1 point only(<2cm)
b) Around wound(>2cm)
c) Large volume
d) Prolonged (>3 days)

Grade IV- Pus

a) At 1 point only(<2cm)
b) Along wound(>2cm)

Grade V: Deep or severe wound infection with or without tissue breakdown or haematoma requiring aspiration.

The wounds are split into four categories[13]:

a) Normal healing
b) Minor complication
c) Major complication: wound infection graded IV or V or wounds treated with antibiotics after discharge from hospital
d) Major haematoma: wound requiring aspiration or evacuation

Method of Analysis

The data was analyzed using EPI info version 7 and International Business Machine Corporation statistical package for social sciences (IBM SPSS) version 25. The result was presented with the aid of tables. Chi square testing was done to ascertain the level of significance of variables. Confidence interval was calculated at 95% probability level ($p<0.05$).

Results

A total of 48 patients who met the inclusion criteria were enrolled into this study. All the enrolled patients completed the study. Group A was made up of 24 patients who had active wound drain (EMVAC) while Group B comprised of 24 patients who had close passive wound drain (urine bag). The mean age of all participants was 45.53 ± 18.23 with a range of 19-76 years. The mean age of those who had Active wound drain is 45.88±19.06 while that of close passive wound is 45.17±17.40, the t-test is 0.134 while the p-value is 0.894 meaning that no significant statistical difference between the ages within the same group.

Table 5.1: Shows mean/standard deviation in the age distribution between active and closed passive wound drain.

Age	Active drain(n=24)	Passive drain(n=24)	t-test (p value)
Mean(SD)	45.88±19.06	45.17±17.40	0.134(0.894)

This table 5.1 shows that the two study groups were similar in age (p = 0.89).

Table 5.2: Showed sex frequency and percentage distribution on both Active and closed passive wound drain groups.

Sex	Active Drain (%)	Passive Drain (%)	x^2 *(p value)*
Female	13(54.17)	15(62.50)	0.343(0.558)
Male	11(45.83)	9(37.5)	
Total	24(100.00)	24(100.00)	

Table 5.3: Shows educational status, religion, ethnicity and occupation of participants on both study groups.

Educational Status	Active Drain (%)	Passive Drain (%)	x^2 *(p value)*
Primary	2(8.33)	5(20.83)	1.520(0.468)
Secondary	12(50.00)	10(41.67)	
Tertiary	10(41.67)	9(37.50)	
Total	24(100.00)	24(100.00)	
Religion			
Christians	24(100.00)	24(100.00)	
Ethnicity			
Igbo	23(95.83)	22(91.67)	1.022(0.600)
Efik	1(4.1)	1(4.17)	
Yoruba	0(0.00)	1(4.17)	
Total	24(100.00)	24(100.00)	
Occupation			
Paid Employment	3(12.50)	3(12.50)	0.111(0.946)
Self Employed	14(58.33)	15(62.50)	
Unemployed	7(29.17)	6(25.00)	
Total	24(100.00)	24(100.00)	

The educational status, religious status, ethnicity and occupational status of participants in the two study groups as shown in table 5.3 were similar with p- value of 0.46 and x^2 of 1.52.

Table 5.4: Shows diagnosis of participants on both study groups

Diagnosis	Active Drain (%)	Passive Drain (%)	x^2 *(p value)*
Acute Fractures	9(37.50)	14(58.33)	2.516(0.284)
Malunion	3(12.5)	1(4.17)	
Nonunion	12(50.00)	9(37.50)	
Total	24(100.00)	24(100.00)	

The diagnosis of the study participants as shown in table 5.4 were similar in both active and closed passive wound drain groups with x^2 = 2.516 and p- value= 0.284.

Table 5.5.1: Shows mean vital signs, anthropometry and haemoglobin of participants on both study groups.

	Active Drain(n=24)	Passive Drain(n=24)	*t-test (p-value)*
Mean Pulse rate (bpm)	84.3±8.0	85.0±10.2	0.284(0.778)
Mean Blood Pressure(mmHg)	122/76±14/8	122/77±10/5	0.319(0.715)
Mean Respiratory Rate(cpm)	21±2	21±3	0.525(0.602)
Mean Weight (Kg)	71.5±9.7	73.3±8.4	0.635(0.529)
Mean Height (m)	1.64±0.06	1.63±0.07	0.150(0.882)
Mean BMI	26.7±2.9	27.6±3.5	0.934(0.335)
Mean Haemoglobin (g/dl)	11.9±1.0	11.8±0.8	0.277(0.783)

The mean vital signs, anthropometry and haemoglobin of participants on both groups were similar as Shown in table 5.5.1.

Table 5.5.2: Shows location of the fracture site on both active and closed passive wound drain.

Location of Fracture Site	Active Drain	Passive Drain	x^2 *(p-value)*
Intertrochanteric Fracture	1	0	9.01(0.252)
Femoral Shaft fracture	15	21	
Subtrochanteric fracture	2	0	
Tibiofibular Fracture Distal Third	2	0	
Tibia Plateau Fracture(lateral tibia)	1	0	
Tibia Fracture/Malleolar Fracture	1	0	
Tibia Fracture Distal Third	1	2	
Tibia Fracture Middle Third	1	0	
Comminuted Femoral Shaft Fracture	0	1	
Total	**24**	**24**	

The location of the fracture site of the participants as shown in table 5.5.2 were similar on both study groups with p- value of 0.252 and x^2 of 9.01.

Table 5.6.1: Shows various surgical approaches of participants on both active and closed passive wound drain.

Surgical Approach	Active Drain	Passive Drain	x^2 *(p-value)*
Posterolateral	18	21	6.11(0.412)
Anterior/Direct Lateral	2	0	
Anterolateral	1	0	
Anteromedial	2	2	
Anterior	1	0	
Lateral	0	1	
Total	24	24	

The surgical approaches of participants on both study groups were similar with p- value of 0.41 and x^2 of 6.11.

Table 5.6.2: Shows types of surgery done on the participants of both active and closed passive wound Drain study groups.

	Active Drain (n=24)	Passive Drain (n=24)	x2 (p value)
ORIF with IM Nailing	11(100.00)	12(100.00)	0.510(0.775)
Grafted	5(45.45)	4(33.33)	
Non-grafted	6(54.54)	8(66.67)	
ORIF with Plates and Screws	9(100.00)	12(100)	0.778(0.678)
Grafted	4(44.44)	5(41.67)	
Non-grafted	5(55.56)	7(58.33)	
ORIF with PFN	2(100.00)	--	2.087(0.352)
ORIF with DHS	1(50.00)	--	
ORIF with distal tibia plate + Malleolar Screw	1(50.00)	--	
Total	24	24	

The various surgeries done in each of the participants as shown in table 5.6.2 were similar with p- value of 0.77 and x^2 of 0.510.

Table 5.6.3: Shows estimated blood loss of the two study groups.

	Active Drain (=24)	Passive Drain(n=24)	t (p value)
Average Estimated Blood Loss	379.17 ±313.43	406.25 ±254.23	0.329(0.744)

The estimated intraoperative blood loss of the two study groups was similar with t-test of 0.329 and p- value of 0.74.

Table 5.7.1: Shows surgical site infection postoperatively using Southampton grading.

	Active Drain(n=24)	Passive Drain(n=24)	x^2 *(p value)*
Surgical site Infection			
3 Days Postop			
Normal Healing	9(37.50)	6(25.00)	4.067(0.397)
Mild Erythema	7(29.1)	13(54.17)	
Erythema+ other signs of inflammation	3(12.50)	3(12.50)	
Clear or haemoserous discharge	4(16.67)	2(8.33)	
Purulent discharge	1(4.17)	--	
Total	24(100.00)	24(100.00)	
7 Days Postop			
Normal Healing	6(25.00)	12(50.00)	4.177(0.243)
Mild Erythema	8(33.33)	6(25.00)	
Erythema+ other signs of inflammation	6(25.00)	5(20.83)	
Clear or haemoserous discharge	4(16.67)	1(4.17)	
Total	24(100.00)	24(100.00)	
14 Days Postop			
Normal Healing	15(62.50)	21(87.50)	4.333(0.228)
Mild Erythema	6(25.00)	2(8.33)	
Erythema+ other signs of inflammation	2(8.33)	1(4.1)	
Clear or haemoserous discharge	1(4.17)	--	
Total	24(100.00)	24(100.00)	
28 Day Postop			
Normal Healing	23(95.83)	24(100.00)	1.021(0.312)
Mild Erythema	1(4.17)	--	
Total	24(100.00)	24(100.00)	

The surgical site infection of the two study groups were similar from day 3 to day 28 postoperatively with their respective p- value and Chi- square as shown in table 5.7.1.

Table 5.7.2: Shows degree of postoperative wound dehiscence on both active and closed passive wound drain

	Active Drain(n=24)	Passive Drain(n=24)	x^2 *(p value)*
Wound dehiscence	**2(8.30)**	**1(4.20)**	
Degree of Wound Dehiscence			
None (0)	22(91.70)	23(95.80)	0.356(0.551)
Mild(0-30)	2(8.30)	1(4.20)	
Total	24(100.0)	24(100.0)	

The degree of wound dehiscence of the participants on both study groups were similar with p- value of 0.55 and x^2 of 0.35.

Table 5.7.3: Shows comparison of average quantity of effluent between the study groups.

Average Quantity of Effluent	Active Drain(n=24)	Passive Drain(n=24)	*t(p value)*
Day 1(mls)	175.00±72.47	184.17±99.34	0.365(0.717)
Day 2(mls)	69.37± 28.14	74.17±22.83	0.648(0.520)
Total (mls)	244.37±86.54	258.34±110.76	

The average quantity of effluent as shown in table 5.7.3 for the two study groups were similar with their respective t-test of and p- value.

Table 5.7.4: Shows postoperative pain using Numeric Rating Scale.

Postoperative pain assessment 12 Hrs post-opp	Active Drain(n=24)	Passive Drain(n=24)	x^2 *(p value)*
Mild	3(12.50)	--	5.75(0.124)
Moderate	6(25.00)	3(12.50)	
Severe	12(50.00)	14(58.33)	
Very Severe	3(12.50)	7(29.17)	
Total	24(100.00)	24(100.00)	
24Hrs Post-opp			
Mild	2(8.33)	1(4.17)	6.60(0.086)
Moderate	12(50.00)	5(20.83)	
Severe	10(41.67)	16(66.67)	
Very Severe	--	2(8.33)	
Total	24(100.00)	24(100.00)	
2days Post-opp			
Mild	5(20.83)	4(16.67)	3.53(0.171)
Moderate	14(58.33)	19(79.17)	
Severe	5(20.83)	1(4.17)	
Total	24(100.00)	24(100.00)	
7day Post-opp			
Mild	17(70.83)	14(58.33)	2.29(0.318)
Moderate	6(25.00)	10(41.67)	
Severe	1(4.17)	--	
Total	24(100.00)	24(100.00)	
14days Postop			
None	1(4.17)	2(8.33)	2.36(0.308)
Mild	21(87.50)	22(91.67)	
Moderate	2(8.33)	--	
Total	24(100.00)	24(100.00)	

The postoperative pain scores were similar in both study groups as shown in table 5.7.4 from 12 hours to 14 days postoperatively with their respective p- value and chi-square.

Table 5.7.5: Shows nature of wound dressing of both active and closed passive wound drain study groups.

	Active Drain(n=24)	Passive Drain(n=24)	x^2 *(p value)*
Wound Dressing Day 1			
Clean and Dry	12(50.00)	12(50.00)	3.429(0.330)
Mildly Soaked/Strike Through	12(50.00)	9(37.50)	
Moderately Soaked	--	2(8.33)	
Severely Soaked	--	1(4.17)	
Total	24(100.00)	24(100.00)	
Wound Dressing Day 2			
Clean and Dry	14(58.33)	14(58.33)	1.059(0.787)
Mildly Soaked/Strike Through	9(37.50)	8(33.33)	
Moderately Soaked	1(4.17)	1(4.17)	
Severely Soaked	--	1(4.17)	
Total	24(100.00)	24(100.00)	

The wound dressing of the participants on both study groups from day 1 to day2 were similar with their respective p- value and chi-square as shown in table 5.7.5.

Table 5.7.6: Shows average length of hospital stay of the participants on active and closed passive wound drain study groups.

	Active Drain(n=24)	**Passive Drain(n=24)**	***x^2 (p value)***
Average Length of Hospital Stay (Days)	21.13±11.61	19.29±10.82	0.570 (0.57)

Table 5.7.7: Shows average cost of wound drains alone on both active and closed passive wound drain study groups.

	Active Drain(n=24)	**Passive Drain(n=24)**	***x^2 (p-value)***
Average Cost of drains alone(N)	4,095.83±478.66	195.83±17.30	39.890 (<0.001)

Discussion

The aim of this study was to evaluate the early outcome of use of active versus closed passive wound drain in ORIF of lower extremity fractures as regards to postoperative infection, wound dehiscence, pain, length of hospital stay, and cost of wound drain alone. Studies have shown that there was no significant difference in outcome of infection rate and NRS score between no wound drainage and closed drainage [14]. The mean age and sex distribution of the participants in the two study groups were similar. There was no statistically significant difference in the mean age and sex distribution of the participants on both study groups. This falls within the active age group and similar to the work done by other researchers [14]. The mode of presentation and diagnosis of the participants on both study groups were similar. There was no statistically significant difference in their mode of presentation or diagnosis. This is similar to the work done by Akinyoola *et al.* [15] and Muoghalu *et al.* [16] The location of the fractures with their respective surgical approaches were similar on both study groups. The different location of fracture sites was responsible for the different surgical approaches used for the participants on both study groups. There was no statistically significant difference on both study groups. The postoperative surgical site infection rate of the participants on both study groups were similar. The reasons for the surgical site infection observed on both study groups was not clear. But traffic in theatre, change of wound dressing in the ward might have contributed. The wound infections were all minor and one major surgical site infection ranging from mild erythema to a purulent discharge and were treated by antibiotics and wound dressing with no need for debridement. The infection rate was not statistically significant for the 2 study groups. This finding was similar to other researchers (Abolghasemian *et al.*) [17]. Kelly *et al.* [18] also reported similar outcome of no significant difference in wound infection rate in their study. Moreover, these findings were also in keeping with those of Si *et al.* 2016 [14]. The overall wound infection rate in this study (days 3-28) is similar to other researchers with infection rate of 2.7%-18% [15]. The postoperative pain was similar on both study groups. This postoperative pain was as a result of failure of early administration of postoperative analgesia and waning off anaesthetic drugs following recovery. This observation in the two study groups was similar to other researchers who reported no significant difference in postoperative pain between drain and non-drain groups (Fichman *et al.*) [19]. Horstmann *et al.* [20] also reported no difference in outcome of postoperative pain between drain group and no-drain group in their study. This is also similar to other researchers who reported that drains did not lower postoperative pain, swelling and ecchymosis (Fan *et al.* 2013) [21]. The average quantity of effluent was more on day 1 compared to day 2 as result haematoma accumulated from extensive dissected raw areas. But there was no significant difference between the average quantity of effluent drained between the 2 study groups. This observation was similar to the studies done by other researchers (Akinyoola *et al.* and Muoghalu *et al.*) [15, 16]

The soaking of wound dressing of participants on both study groups were similar. The soaking of wound dressing observed on both study groups were as a result of extensive dissected raw areas from malunion and nonunion. Also most of this fluid which escaped from wound drain were soaked by the dressing. There was no significant difference in the soaking of wound dressing between the two study groups. This was in agreement to other researchers who reported similar outcome [16].

The average length of hospital stay was similar on both study groups. The length of hospital stay was as a result of staged procedures done on most of the participants. There was no statistically significant difference between the 2 study groups. This finding was similar to the work done by other researchers who reported similar findings in their work [16].

The average cost of active wound drain alone in group A in naira was 4,095.83±478.66 while the average cost of closed passive wound drain alone in group B in naira was 195.83±17.30. These wound drains were bought at different times based on resources available to the researcher. The t- test between the two groups was 39.89 and the p value was < 0.001. This is statistically significant because the average cost of active wound drain is 20- 30 times the cost of closed passive wound drain. This finding was in keeping with the work done by Adeleye and colleague [22].

Conclusion

There was no statistically significant difference in the incidence of wound infection, wound dehiscence, quantity of effluent, soaking of wound dressing/strike through, length of hospital stays and postoperative pain using NRS (Numeric Rating Scale). There was no clinically or statistically difference in the outcome of participants on both study groups. That is, both study groups have similar outcome.

There was statistically significant difference in the cost of wound drain alone between the two study groups because, cost of wound drain in group A is 20 to 30 times the cost of wound drain in group B.

Recommendation

From this study it is recommended that urine bag can be safely used as a closed passive wound drain especially in low resource setting because it is cheap, simple, similar complication rate and readily available.

Active wound drain can be preferably used when wound drain is indicated where resources is not a challenge.

Further study on the topic will go a long way to add to the body of knowledge.

Conflict of Interest
Not available

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