Sutured and Open Clean-Contaminated and Contaminated Laparotomy Wounds at Muhimbili National Hospital: A Comparison Of Complications.

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Background: Whether to close or leave open an abdominal incision wound depends on the degree of wound contamination at the end of operation. The aim of this study was to compare the complication rates between delayed primary closure and primarily closed laparotomy wounds for clean-contaminated and contaminated abdominal operations.
Methods: Eighty-six patients undergoing laparotomy were included in a randomized clinical trial. Patients were randomized to have their wounds left open or closed primarily. In this study, all patients received Ceftriaxone Sodium (Powercef ®) as a prophylactic antibiotic at the time of induction of anaesthesia.
Results: There was a statistically significant difference (p=0.002) in wound infection rate between those wounds left open (30.2%) and those closed primarily (2.1%). It required a longer duration of time for dressing those wounds left open compared to those closed primarily, The average duration for wound dressing was 16 days for open wounds compared to 11 days for primarily closed ones (p=0.0002). There was no significant difference in the development of wound dehiscence between the two groups (p>0.05). No death was related to wound complication.
Conclusion: Clean-contaminated and contaminated laparotomy wounds should be closed primarily if no gross spillage of visceral contents occurs during operation and a patient receives prophylactic antibiotics.

Introduction

Abdominal incisions should be planned to give adequate access to the operative field, but at the same time to inflict the minimum of damage to the abdominal wall, so that a strong and durable scar results. The midline incision is commonly used in abdominal operations[1].
The decision to close incisional wound depends on the degree of wound contamination at the end of the operation[2]. If the wound is grossly contaminated, primary closure of the wound should be avoided and delayed primary closure should be considered only on or after the fourth day after wounding. On the fourth day; the number of phagocytic cells has reached a peak, capillary budding is intense at this time, and the number of organisms required to initiate an infection in a surgical incision, progressively increases as the interval of healing increases, up to the fifth postoperative day. Edlich *et al*[3] in1969 while studying the management of the contaminated wound found that the optimal time for closure of the contaminated wound without risk of subsequent infection was on the fourth post-wounding day. In this study it was also found that open wounds are resistant to infection on the fourth postoperative day due to greater inflammatory response than closed wounds. Superficial open wounds from contaminated operations have a marked decrease in inflammatory oedema and pain and enhanced formation of granulation tissue than the primarily closed wounds[4,5].

Open wounds should be dressed with a thin layer of dressing to allow oxygenation and should be maintained moist to encourage healing [4, 6].

Delayed primary skin closure of laparotomy wounds has been shown to have significantly reduced the rates of superficial wound infections[5, 7, 8, 9, 10].
The administration of prophylactic antibiotics is indicated for clean-contaminated and contaminated wounds to reduce the rate of wound infections[11,12,13]. Studies have shown that risk of infection in these patients is 10% and 20% respectively when prophylactic antibiotic is given and higher if no prophylactic antibiotic is given.

The study was designed to compare the complication rates between delayed primary closure and primarily closed laparotomy wounds for clean-contaminated and contaminated abdominal operations. Study objectives were to determine the proportion of patients developing pus discharge and wound dehiscence within four weeks of laparotomy, to determine the duration of wound dressing following laparotomy and to determine the influence of wound healing with the mortality.

Patients and Methodology

This was a randomized clinical trial to compare the complication rates in clean-contaminated and contaminated laparotomy wounds between those primarily closed and those left open. The study covered a duration of nine months, from January 2001 up to September 2001. During this period, the author was one of the team members in the management of these patients. The study was done in the Department of Surgery at Muhimbili National Hospital (MNH), Dar es Salaam, Tanzania.

The studied population included all patients admitted in the General Surgery Department, Muhimbili National Hospital, and included all age groups and both sexes who were assessed as having clean-contaminated and contaminated laparotomy wounds. Patients who did not receive perioperative Ceftriaxone Sodium (Powercef ®) were excluded from the study. Exclusion criteria also included all patients with jaundice, diabetes mellitus, advanced malignancy; patients on steroids and age above 65 years as well as all cases of penetrating abdominal wounds who, at laparotomy, were found to have no hollow visceral perforation.

The sample size was estimated to be 86 patients, 43 from each group and sampling procedure was simple randomization, by alternating technique. Questionnaire forms were used to enter the data. Registrars and residents in the Department of Surgery as well as other members of staff were involved in this study in collaborating with the author.

Approach for a typical case of intra-abdominal contamination included:

1. Suction of contaminants
2. Definitive surgery with controlled haemostasis
3. Copious peritoneal lavage using warm normal saline
4. Deep abdominal wall (peritoneum and fascia) closure, using non-absorbable, monofilament, number zero or number one sutures (in adult) and 2/0 in children, either interrupted or continuous, with security sutures. Needle entry was not less than one centimeter from the edge and sutures were made tension free.
5. Superficial wound irrigation with normal saline.
6. Finally, the wound was either closed primarily or left open according to randomization.

Wound Dressing

Wounds were dressed with a thin layer of wet gauze for open wounds and dry gauze for closed wounds. Dressings were not changed unless when found to be stained with bloody discharge or purulent discharge. If there was no evidence of purulent discharge on the fifth day of laparotomy, then the wound was closed as delayed primary closure and the dressing was left until the seventh day of suturing when sutures were removed.

A wound with purulent discharge was cleansed and dressed with Eusol daily until it granulated well for secondary closure. Those wounds closed primarily with no evidence of infection noticed on seventh day following laparotomy had sutures removed and dressing stopped on the same day.

Wound Infection

The wound was considered to be infected if there was pain accompanied by swelling, redness or purulent discharge from the wound whether closed or open.

Wound Dehiscence

This was considered when there was a gaping of the surgical wound with or without evisceration of abdominal contents. These patients were followed up by the author as follows; 5th, 10th and 28th postoperative days including both inpatients as well as outpatients to assess any complication arising from, or related to the wound. At the end of the study, all data and results obtained were analyzed using Epiinfo 6

computer program to determine if there were statistically significant differences between the two groups.

The Research, Ethical and Publication Committee of the Muhimbili University College of Health Sciences (MUCHS) granted ethical clearance for the study.

Results

Patient Population

During the study period, January 1st 2001 to September 30th 2001 a total of ninety-six patients with clean-contaminated and contaminated abdominal wounds were enrolled into the study. Among these patients ninety (93.7%) met the inclusion criteria for the study. These patients included those operated upon on emergency basis (50 patients) and scheduled operation (40 patients). Six patients were excluded from the study as they died before first assessment due to intestinal obstruction.

Age And Sex

The patients' median age was 32.0 years with a standard deviation of 16.7. The peak age was 20-40, which accounted for 50% of the studied patients. The extremes of age had a minority of patients whereby; twenty years of age or below accounted for 14.5% and above sixty years of age accounted for 13.3% of the studied population. In this study, there were sixty-seven males (74%) and twenty-three females (25.6%) making a male to female ratio of 2.9 to 1. Table 1 summarizes these results.

Table 1. Distribution of patients by age and sex.

AGE GROUP (YRS)	SEX		TOTAL (%)
	Male	Female	
≤20	9	4	13 (14.5)
21 – 40	36	9	45 (50.0)
41 – 60	16	4	20 (22.2)
61 – 65	6	6	12 (13.3)
TOTAL	67 (74.4%)	23 (25.6%)	90 (100%)

Wound Management

In the final wound management, patients were simply randomized either for primary skin closure or open method. Forty-seven patients had their wounds closed primarily and forty-three patients had their wounds left open. Among those who had their wounds left open, thirty-two had delayed primary closure done on the fourth day and eleven patients had secondary suturing. Table 2 summarizes the above information.

Wound Dressing

While comparing the total duration of time required for wound dressing it was found that the overall mean was thirteen days. The mean duration for dressing the primarily closed wounds was eleven days compared to sixteen days for those who had open wounds. Table 3 summarizes this information.

Wound Complications

During follow up it was found that on the fifth day post laparotomy seventy-six patients (84.4%) had no pus discharge or wound dehiscence while fourteen (pus discharge. Among those who had open wounds thirty patients (69.8%) had no complications compared to thirteen patients (30.2%) who developed pus discharge. Table 4 summarizes the above information.

Table 2. Distribution of patients according to method of wound management.

Type Of Wound Management		Frequency	%
Primary skin closure		47	52.2
Open wounds	Delayed Primary closure	32	35.6
	Secondary closure	11	13.2
TOTAL		90	100

Table 3. Type of wound treatment and mean duration of wound dressing.

Type Of Wound Treatment	Mean Duration Of Dressing (Days)
Primary skin closure	11 (SD = 4.5)
Open wounds	16 (SD = 6.7)

p = 0.0002 t = 3.8 d.f=1

SD - standard deviation

d.f - degree of freedom

Among those who had their wounds closed primarily, forty-six (97.9%) had no complications. One patient (2.1%) developed

On the 10th postoperative day, the overall wound infection rate was 14.4%. One patient (1.2%) developed wound dehiscence. It was found that among those patients whose wounds were closed primarily, 45 (95.8%) had no complications; one (2.1%) had pus discharge and one developed wound dehiscence. Among patients who had open wounds, 31 (72.1%) had no complications, twelve (27.9%) had pus discharge and none developed wound dehiscence (Table 5).

During follow up on the twenty eighth day of laparotomy eighty-one patients (92%) had no complication while overall, seven patients (8%) had pus discharge. On comparing the two groups, among the patients who had primary skin closure, two patients (4.3%) had pus discharge while those with open wounds; five (11.9%) had pus discharge.

Mortality

During follow up of the two patients (2.2%) who died, one had primary skin closure and the other had delayed primary closure. Both deaths were unrelated to wound complications.

Table 4. Distribution of patients by wound treatment and pus discharge on fifth day post laparotomy.

Type Of Wound Treatment	Complication		Total
	No complication	Pus discharge	
Primary skin closure	46 (97.1%)	1 (2.1%)	47 (100)
Open wounds	30 (69.8%)	13 (30.2%)	43 (100)
TOTAL	76 (84.4%)	14 (15.6%)	90 (100)

p = 0.0002 X^2=13.5 d.f=1

Table 5. Distribution of patients by wound treatment and development of pus discharge and wound dehiscence on tenth day post laparotomy

Type Of Wound Treatment	Complications			TOTAL
	No complication	Pus discharge*	Wound dehiscence+	
Primary skin closure	45 (95.8%)	1 (2.1%)	1 (2.1%)	47
Open wounds	31 (72.1%)	12 (27.9%)	0 (0.0%)	43
TOTAL	76 (84.4%)	13 (14.4%)	1 (1.1%)	90

*p = 0.002 +p > 0.05. Yates corrected X^2=0.84 d.f=1 p=0.4)

Discussion

In the current study, it was found that it took a relatively longer period to dress wounds left open than those closed primarily and the difference was statistically significant (p = 0.0002).

The prevalence of wound infection was 15.6% in this study which was comparable with findings of 10% to 20% reported in previous studies from elsewhere[14,15,16] for clean-

contaminated and contaminated wounds. This may be explained by the adherence to standard surgical technique as well as use of antimicrobial surgical prophylaxis (Powercef®). In this study, the rate of wound infection of 30.2% was higher for those wounds which were left open, compared to those closed primarily (2.1%). This statistically significant difference (p = 0.0002) contrasted with what was found in other studies[5, 7, 8, 9,10].

Paul et al[5] in 1976 found the prevalence of wound infection in primary skin closure of 11.8% compared to 5.8% in delayed primary closure. Meissener and Meiser[7], found the prevalence of wound infection of 39% in primary skin closure compared to none in open wound treatment. Delayed primary wound closure, for selected clean-contaminated or dirty wounds reduce significantly the rate of wound infection[8]. Smilanich et al[9], found the prevalence of wound infection of 27% in wounds closed primarily compared to 3% for delayed primary closure. Higher prevalence of infection for open wounds compared to closed wounds (30.2% versus 2.1%) in this study could in part be explained by the high risk of wound contamination from the patients' skin and

environmental sources during frequent dressing changes of the open wounds.

Scott et al[10] studied the influence of wound closure on wound healing and found that, delayed primary closure or secondary closure of skin and subcutaneous fat in contaminated laparotomy incisions eliminates the risk of wound infection and incisional hernia. Open wounds stimulate collagen synthesis and improve wound strength. In this study the following factors were noted:

- On the day of the Major Ward Rounds all wounds whether infected or not were undressed for several hours in order to be inspected by doctors.
- Frequently the wards were overcrowded especially following a day of admission. Overcrowding caused postoperative patients to be placed near or between patients with septic conditions. It also made it difficult to maintain proper hygienic conditions in the wards.

These factors seem to predispose open wounds to higher risk of infection than closed wounds. Forrester[24] found that undisturbed open wounds heal better and dressings may therefore impair the healing of open wounds by damaging the delicate new cells and capillaries on the wound surface. Therefore unless infected, wound dressings should not be changed. In another study it was found that wounds that are left open tend to become dry and covered by a hard crust that delays healing[18].

In a study by Wayi[19] at the Muhimbili National Hospital in Dar es Salaam, the clinical infection rate of clean operations was 12.9%. The commonest organisms in his study included Staphylococcus aureus, Klebsiella, Escherichia coli, Pseudomonas, Proteus, and Streptococcus. This suggests that environmental as well as patients' skin are important sources of infection.

By the 10th post-laparotomy day, wound infection had become a complication in 14.4% of cases; one patient (1.2%) developed wound dehiscence. A higher infection rate occurred in those with open wounds, compared those closed primarily. The difference was statistically significant (p=0.002).

In this study, development of wound dehiscence was not a major problem (1.2%). This shows that, most of the wound infection was superficial rather than deep infection involving deep fascia or intraabdominal sepsis.

Jurkovich and Carrico[20] found that the causes of abdominal wound dehiscence include:

- Poor wound closure technique
- Increased intra-abdominal pressure from bowel distension, ascites, coughing, vomiting or straining
- Haematoma with or without infection
- Infection and
- Metabolic diseases such as diabetes mellitus, uraemia, Cushing disease and malignancy.

Senbanjo and Ajayi[21] found the rate of abdominal wound dehiscence of 2.5% with mortality rate of 7% while Fleischer et al[22], found that the rate of abdominal wound dehiscence was 1% with a mortality rate of 15% to 45%. The predisposing factors were local wound infection and poor technique. Bucknall[23] found that the rate of wound dehiscence was 1.7% and this was associated with wound infection.

Mass-closure is reported to reduce the dehiscence rate from 3.8% to 0.76%. A monofilament non-absorbable suture was concluded to be most suitable suture for closing contaminated and infected abdominal wounds.

Bucknall et al[24] in 1982, found that mass-closure technique reduced the incidence of wound dehiscence from 3% to 0.95%. Gislason et al[25] found that the surgeon is a risk factor in wound complications following gastrointestinal operations. Several studies have been done on incisions, closure technique, and suture materials but the most important factor is the individual surgeon. Regular audit with feedback to individual surgeon is an important instrument for quality improvement.

By the 28th post-laparotomy day the overall infection rate was 8%, higher in those wounds left open than those closed primarily (11.9% versus 4.3%). Statistically this difference was not significant ($p = 0.4$). This showed that by the 28th day, no significant difference in wound infection rate between the two groups existed.

Two patients died, but the cause of their death was not related to wound complications. One had purulent cystitis with necrosis of the urinary bladder histologically and died of cerebro-vascular accident on eleventh post-operative day after laparotomy for partial cystectomy.

The second patient died of septicaemia on the 8th day following laparotomy for perforated typhoid ulcer complicated by intraabdominal sepsis. This patient had a clean open wound, which was closed on fifth day of laparotomy and healed well. He remained with a swinging pyrexia and deteriorating condition.

Conclusion

1. In this study, the major complications arising from clean- contaminated and contaminated laparotomy wounds include wound infection and wound dehiscence. The overall infection rate was 15.6%, which was within the normal range of 10-17%. Wound dehiscence accounted for 1.1%.
2. Clean contaminated and contaminated laparotomy wounds can be closed primarily if no gross spillage is encountered during the operation and a patient receives antimicrobial surgical prophylaxis.
3. The rate of wound infection was higher in open wounds than in closed wounds contrary to what is reported in the literature. This was attributed to the contamination during dressing changes mainly from exogenous sources and patients' skin rather than intra-abdominal sources.
4. Open wounds require a longer duration of dressing than closed wounds. This implies more dressing changes during delayed primary closure or secondary suturing, which is inconvenient to the patient as well as being an economic burden. The patient with open wound will require a second operation for wound closure either as delayed primary closure or secondary closure

Recommendations

1. Clean- contaminated and contaminated laparotomy wounds can be closed primarily if no gross spillage is encountered during the operation and a patient receives antimicrobial surgical prophylaxis.
2. Surgical wound dressings should not be changed unless there is evidence of wound infection or on the fifth day of laparotomy for open wounds during delayed primary closure or during sutures removal.
3. There is a need to have a surveillance committee on wound infections in articular type of operations. The surveillance team must give feedback to the concerned surgeon who in turn must review the preventive measures.
4. Further studies need to be done to determine risk factors for open wounds to develop infection, to compare effectiveness of different types of antibiotics and also to compare elective against emergency operations.

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