MANAGEMENT OF PENETRATING COLON INJURIES AT KENYATTA
NATIONAL HOSPITAL: A CRITICAL REVIEW OF PRIMARY
CLOSURE VERSUS  COLOSTOMY.

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BY

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## DECLARATION

I hereby certify that this dissertation is my original
work and has not been submitted for a degree in any other
University.


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THIS WORK IS DEDICATED TO MY LATE GRANDPARENTS

DORA AND JOSIAH.

## ACKNOWLEDGEMENTS

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SUMMARY

This is a review of 45 consecutive cases of penetrating injuries
of the colon treated at Kenyatta National Hospital from 1986 to 1992.
The records of 42 male and 3 female patients (mean age, 28.8 years)
were analysed.  Injuries were due to stabwounds in 66.7% of patients,
and gunshot wounds in 17.8%.  Patients with gunshot wounds had other
injuries more often than did those with stab wounds, and morbidity and
mortality were greater.  Thirty two (71.1%) patients underwent primary
repair without colostomy.  In thirteen (28.9%) a colostomy was constructed.
The overall mortality rate for the series was 4.4% and included two
patients who died within 24 hours of admission.  The overall morbidity
rate was 46%, with surgical wound sepsis contributing significantly to the
high morbidity.

Mortality and morbidity were increased in patients who were in
shock when admitted to the hospital, those with other associated injuries,
multiple colon injury, increasing transfusion requirement, faecal
contamination of the peritoneal cavity, and those delaying by more than
8 hours from injury to operation.  Primary closure of the penetrating
colon wound was significantly superior to colostomy in terms of
morbidity (36.7% vs. 69.2%) and period of hospitalization (13.6 vs. 36.8
day, student's t-test, p less than 0.01).  All documented colostomy
closures (7 cases) were without mortality but with morbidity rate of
28.6%.

In the absence of the above risk factors, the likelihood of infec-
tion is low, suggesting that primary repair or resection and anastomosis
are safe methods of management of colon injury.  When these risk factors
are present, the risk of infection is high and colostomy is the preferred
method of management.  Primary repair should be the mainstay of treatment
of stab wounds of the colon, and the skin and subcutaneous tissue of the
laparotomy wound should be managed by delayed primary suture or allowed
to heal by secondary intent  to minimize wound sepsis.

INTRODUCTION

The first reference to colon injuries can be found in the book of Judges where we read how Ehud stabbed Eglon, King of Moab. Eglon's bowel was perforated and he subsequently died (14,24,26). The eventual outcome in this case, that is, death was the same as what was almost uniformly noted during the many centuries to follow (22,57). Although Lembert in 1827 was the first to record the successful closure of a small bowel perforation, repair of colon wounds consistently failed up until the time of World War I (57).

## Historical review of mortality rates

The mortality and morbidity from acute injuries to the colon have been reduced continously by aggressive surgery during the 20th centrury (27). At the time of the American Civil War mortality of these injuries were almost 100% (9,18,26). During World War I, when the method of treatment was primary closure, the mortality rate was 60% (9,22,26,27,61). In World War II, the preferred method of treatment was exteriorization or proximal colostomy and the mortality rate fell to 30% (9,26,61). In the Korean War the mortality rate further decreased to 15% (22,27). This decrease was achieved by rapid transportation of the injured to hospital (thus reducing the period of potential contamination), antibiotic availability and improvement in resuscitative measures (22,61). In many of the recent civilian series, the mortality of colon wounds has now fallen to less than 5% (9,26,54).

Colon injuries have long been of great interest to surgeons and
have always presented a dilemma for them (22, 32). The very
poor results associated with these injuries probably stimulated
this interest. As long as people continue to quarrel and live
dangerously; these wounds will have a place of importance (22).
In many countries, severe abdominal trauma as a result of civil
violence is on the increase and colon injuries are one of the
commonest problems seen in large metropolitan hospitals. Patients
sustaining colon perforation from abdominal trauma often present
a major challenge in diagnosis and treatment. It is often impo-
ssible to substantiate such injury with certainty until laparotomy
has been performed (48).

The principles of treatment of injuries to the colon have
vacillated widely since the turn of the century (37). The
evolution of operative management of civilian colon injuries
has clearly departed from the military dictum advocating mandatory
colostomy (3,61). Over the last decade, the concept of primary
repair of traumatic colon injuries had gained increasing support
(5, 6, 7, 8, 17, 54, 57, 59). The safety of this practice has
been attested by several authors (39).

In surgical practise in a developing country, colostomy
construction has obvious disadvantages. Colostomies are ill-
managed by the patient due to poor education, the unreliable
supply of collecting appliances and inadequate toilet facilities.
Members of a largely out door population become social recluses
and productive members of society are kept away from the work-
place for prolonged periods of time (39).

## AIM AND OBJECTIVES

### AIM

To critically evaluate primary repair and colostomy in the management of penetrating colon injuries and to suggest a policy of operative treatment of such injuries.

### SPECIFIC OBJECTIVES

1.  To establish the age distribution of colon injuries.

2.  To determine the morbidity and mortality of colon injury.

3.  To determine which factors present before operation and occurring as a result of injury influence the risk of subsequent infectious complications.

4.  To evaluate colostomy and primary repair as modes of management of colon injury.

5.  To establish a policy of treatment of colon injury based on any conclusions drawn from the above observations.

## LITERATURE REVIEW

### Colon anatomy

The colon extends from the ileo-caecal junction to the rectum infront of the third piece of sacrum. It is conveniently considered in four parts; the ascending, transverse, descending and sigmoid. The ascending and descending colon are relatively fixed to the posterior abdominal wall. The lower part of the former may come into contact with the anterior abdominal wall, while its' upper part is covered by coils of small intestines. The hepatic flexure lies infront of inferior pole of the right kidney and is under cover of the inferior surface of the right lobe of the liver. The transverse colon which terminates at the splenic flexure, is variable in position since it has a complete peritoneal investment with a mesentery. It is in contact with the anterior abdominal wall. From right to left, it lies infront of the hilus of the right kidney, the second part of the duodenum and the head of the pancreas successively.

The splenic flexure is in contact with the lower part of the spleen, the greater curvature of the stomach, the tail of the pancreas, and the anterior surface of the left kidney. Anterior to the descending colon, are the coils of jejunum. The sigmoid colon which ends opposite the middle of the sacrum by becoming the rectum, hangs down in the pelvis on the mesentery completely invested in peritoneum. Thus its relations are variable.

Appendices epiploicae which are scattered over the free
surface of the whole colon have no anatomic function but are
often useful in helping to protect a suture line or closure
of a perforation in the colon. The presence of taenia coli
is of convenience in fashioning a colostomy, whence a long-
itudinal opening is made through the prominent antimesenteric
taenia. The site of election of a temporary colostomy being
the right transverse colon which is mobile, has a broad mesen-
tery, and can be brought to the surface easily. The arterial
supply of the right colon, from the ileo-caecal junction to
approximately the mid-transverse colon , is from the superior
mesenteric artery through its ileo-colic, right colic, and middle
colic branches. The left colon is supplied by the upper and
lower left colic and sigmoid arteries, from the inferior mesenteric
artery.

These arteries bifurcate and form arcades about 2.5 cm from
the mesocolic border of the large intestines. From these, there
is a free anastomosis of vessels resulting in the formation of a
single arterial trunk, the marginal artery of Drummond
(14,20,35,49,53)

## Biology of colonic healing

Healing of suture lines in the colon is dependent upon many systemic and local factors. Schrock et al (1972) reviewed factors that seem to predispose to suture line leakage. These factors include, among others, peritonitis from the original contamination, necessity for intraoperative transfusion of more than 4 units of blood, intraoperative hypotension, and metabolic conditions not conducive to good tissue healing, i.e., diabetes, uraemia, malnutrition, old age and immunosuppression from whatever reason (10, 26, 61). Healing of wounds in the colon depends on a balance between synthesis and breakdown of collagen (26, 52, 59). Hunt and Hawley (1969) found that collagen synthesis is retarded in skin wounds after severe remote trauma, probably because of tissue hypoxia, and it is reasonable to extrapolate the same effect to colonic wounds, although this has not been established. Collagen breakdown, caused by the enzyme collagenase, is a physiologic response to colonic wounding (52). Cronin et al (1968) demonstared increased collagenolytic activity in the colonic wall after ijuries and colonic anastomoses (1, 52). Hawley et al (1970) also reported increased amounts of collagenase in the vicinity of infected suture lines as opposed to noninfected ones. The increased collagenolysis could at least be partially responsible for the breakdown of the anastomoses because of weakening of supporting layers of the colonic wall (1). Another, perhaps more critical factor in the anastomotic disruption is the presence of intraluminal bacteria. Bacteria trapped in the suture line could result in a suture line abscess and eventually contribute to necrosis and anastomotic leak.

As pointed out by Hunt and Hawley (1969), the bursting strength
of a colonic suture line is weakest on the third postoperative
day (1, 10, 26, 52).  Disruption of suture lines in the colon is
disastrous complication which is clinically apparent in 5% or
less of all colonic anastomoses despite careful suturing tech-
niques  (1, 52).

Hawley and Hunt and their associates (1970) cited three
properties of collagenase which are particularly significant to
the management of trauma to the colon (52).  These are as follows:

(a)  Collagenase is present in higher concetrations in the colon
     than elsewhere in the gastrointestinal tract.

(b)  It's activity is greater in the left colon than in the right.

(c)  Collagenolytic activity is enhanced at, and immediately
     adjacent to, infected anastomoses compared with noninfected
     ones.

On theoretic grounds, therefore, a greater collagen deficit,
hence a weaker anastomosis, may be expected in the left colon and
in those patients with severe trauma or abdominal sepsis (52, 59).
There has been a common belief that the right side of the colon
heals more reliably than the left side (26, 52, 61).

Factors advanced to account for this purported phenomenon have
been:

  i)  The presence of fewer micro-organisms on the right
      side of the colon.

 ii)  The less-solid nature of the bowel content on the right
      side

iii)  The greater diameter of the right colon.

 iv)  The better blood supply of the right colon.

  v)  The lesser amount of collagenase present to interfere
      with colonic wound healing.

 vi)  The smaller pressures generated in the course of
      peristalsis.

Thompson and coauthors (1981) reported their results of a
retrospective review comparing right-sided colon injuries with
left-sided ones and concluded that right-sided injuries do not
behave more favourably than left-sided injuries, and that despite
the anatomic and physiologic differences, both should be managed
similarly (26, 52).  Schrock et al (1973), Irvin and Goligher
(1973) have found that proximal decompression does not protect
against the development of anastomic disruption (21, 59).

## COLON INJURIES

Colonic injuries occur in 17% (25) of penetrating abdominal trauma and are usually due to stab or gunshot wounds, colonic injury secondary to blunt trauma is rare (6,12,21,22,25,31,37). These injuries occur predominantly in young males, with a male-female sex ratio reported in various series from 3 : 1 to 23 : 1 (3,6,8,15,22,28,50,51,54).

Isolated injury to the colon is  uncommon, more often such injury is associated with trauma to other intra-abdominal organs (47).  Concomitant abdominal organs most likely to be injured are, in descending order of frequency, the small instestine, liver, stomach, major vessels, kidney, spleen, pancreas, and duodenum (61).  The mortality rate rises steeply with the incr-ease in the number of organs injured, and in this regard, gunshot wounds account for eightfold to tenfold mortality as compared to stab wounds (2,13,27,28,55,61).

Infection remains the major cause of post-operative morbidity and mortality, following injury to the colon (11,13,19). Some factors are identified that predispose the patient with injury to the large intestine to develop infection.  The bacterial content of the large intestine is the highest of all the intra-abdominal viscera, measuring $10^{12}$  bacteria per gram of stool and anaerobic flora predominating (12,21,55). Therefore, a small inoculum of faeces in the peritoneal cavity can result in a high infection rate (1,11,12,13,40,56).

Non - surgical factors affecting outcome

Certain risk factors prediscpose the patient with injury to the colon to develop post-operative infection (2,12, 13, 26, 40, 52, 61). These are outlined below:-

1). Shock

Shock has been a relative contraindication to primary repair for many years. During periods of even transient hypotension, blood flow to the bowel is reduced and may be a factor in the development of anastomotic leaks. George et al. (1989) recently reported a prospective series of 102 patients in which the presence of shock did not significantly contribute to post-operative sepsis (26). And Burch et al. (1986) disagree with those who maintain that primary repair should not be used in the presence of shock (6). These authors contend that simple closure of small wounds may save further blood loss and operating time.

2). Faecal contamination

This is another risk factor that influences the ultimate management decision, but it is difficult to assess because of its subjectivity. Increasing the amount of contamination depresses the ability of the host to cope with a bacterial load, and the addition of blood to the contaminated abdomen impairs bacterial clearance from the

peritoneal cavity. In their retrospective study, Nelkin and Lewis (1989) noted that major complications were prevalent in patients with high degree of faecal spillage (26).

3) Associated injuries

The number of associated injuries provides not only a measure of the severity of the traumatic insult but has also been shown to be related to the likelihood of developing infectious complication after colon injury. Burch et al (1986) notes that, among other factors, mortality is related to number and complexity of associated injuries (6).

4) Delay from injury to repair

This may have an impact on the decision process. A delay of more than 6 to 8 hours has been associated with increased infection after colon trauma. Time on its own is not a determinant of prognosis (2), but delay plus gross faecal soiling may be a meaningful criterion on which to base management decisions. A long delay in the absence of peritoneal contamination can occur without ill effect and indicates that the bowel injury has been walled off.

5) Age

Both Nichols et al (1984) and dellinger et al (1984) have found that age is an important predictor of risk for infection in patients with penetrating abdominal trauma (13, 40). This

observation has also been made by other investigators who have looked specifically at colon injury (28,63). Aging is associated with an increased frequency of chronic diseases and alteration in T-lymphocyte function (12). Burch et al (1986) identified patients over age 40 as being at risk of increased mortality (6).

6). Mechanism of injury

Mechanism of injury does not seem to be as important a risk factor as some of the others. Patients sustaining ballistic wounds tend to have more serious injuries due to shock waves and cavitation phenomena (44,47,48). Conversely, stab wounds generally produce less severe injury and are generally amenable to primary repair.

Classification

Flint et al. (1981) developed a grading system for colon injuries based on the degree of contamination, the number of associated organ injuries, shock, and time between injury and operation (17). This intraoperative classification is the most simple and has been used to determine the type of repair that is most appropriate.

Clinical considerations

Colonic injuries are commonly first recognized at routine laparotomy for penetrating wounds of the abdomen, but prior diagnosis may be made if there is faecal drainage (21,31). The possibility of a colonic wound must be strongly entertained in any patient who has a stab or gunshot wound in the area from the nipples to the

pubis, over both the anterior and posterior aspects of the torso

(61). Extraperitoneal colonic injury is extremely difficult

to diagnose and therefore, a high index of suspicion has to

be maintained. Radiological studies of the abdomen usually are

not helpful because pneumoperitoneum is uncommon (25,37,50,61).

Kester et al (1986) analysed 94 abdominal X-rays obtained from

patients with stab wounds to the abdomen retrospectively and concluded

that reliability in demonstrating intestinal injury was poor. They

recommended that routine radiographs in the initial evaluation of stab

wounds to the abdomen is not cost effective and therefore unnecessary

(29). However plain anteroposterior and lateral X-rays of the abdomen

in cases of missile injury to the abdomen may demonstrate the presence

of one or more bullets or other foreign bodies and help in their locali-

sation if there is no exit wound (4, 48, 61).

Although most laboratory studies are not helpful, nevertheless

peritoneal lavage is of value if intraperitoneal colonic injury is

present and may return fluid with blood or bacteria. Operation should

follow whenever red blood cell count greater than 100,000 per mL, white

blood cell count greater than 500 per mL is present or faeces, or bacteria

is noted (21,25,31,61).

PRINCIPLES OF MANAGEMENT

The initial patient management consists of maintenance of an

efficient air way, respiratory support as needed, halting any obvious

external haemorrhage, and placing one or more intravenous lines

having drawn blood for grouping and cross matching (6,47,63).

Urgent resuscitative measures are often paramount and frequently
have to take precedence over investigative procedures (48). The general
state of the patient is then rapidly assessed, history and physical
examination being performed expeditiously (6,27,47,60). After
haemodynamic stabilization, the patient undergoes appropriate further
investigations as indicated before surgery. Nasogastric tube is
placed and all patients receive preoperative broadspectrum systemic
antibiotics and tetanus prophylaxis (2,4,6,7,8,25,27,31,37,59,60,61,63).

The antibiotics should possess anaerobic and aerobic activity whenever
the possibility of colonic injury is entertained (19,42,55). If no
contamination is found at the time of operation, the antibiotics can be
stopped in the immediate post-operative period. If contamination
is present, cultures are taken at operation and antibiotics continued for
for five days in these cases (37, 42, 61).

Operative management

     As the probability of significant intra-abdominal injury is
high, exploration in all gunshot wounds of the abdomen  is mandatory,
except in those patients where there is clearly no  possibility
of survival (17,25,37,45,48,59). Selective laparotomy should be adopted
for patients with abdominal stab wounds, using local wound explo-
ration and diagnostic peritoneal lavage as suggested by Thal and
associates (17,37,59). When a policy of selective laparotomy is
followed,any degree of abdominal tenderness or guarding mandates
operative intervention (37). Laparotomy is undertaken through a
generous midline incision since this gives rapid access, permits wide
extension, insures adequate exposure, and does not interfere with any

stomas that may be constructed (4,6,27,37,47,48,61). After the peritoneal cavity is opened, the surgeon's first priority is the identification and control of any source of acute major haemorrhage (27,45,48,61). Once this is accomplished, attention is directed toward leaking hollow visceral perforations, which initially should be closed by suture or non-crushing intestinal clamps to obviate further spillage of faecal contents (6,27,37,45,48,61). Once life-threatening injuries within the abdominal cavity are controlled, attention is turned towards the viscus injury for definitive treatment (9). By warm saline irrigation of the peritoneal cavity and suction, faecal contamination is removed before further surgery is performed (6,36,47,61). There is no single policy of management which is applicable to all forms of colon injury (27,47,48,63). Primary repair of the colon can be risky and ill advised in many situations, whereas colostomy may be unnecessary in other circumstances. The surgical choice depends on the patient's general condition, the site and severity of associated injuries, the duration and degree of peritoneal contamination, the site and extent of colonic injury, the extent of faecal loading and the expertise of the surgeon (1,17,21,31,37,47,61). The surgical options (21,31,45,48,50,61) applicable in the management of colonic injuries are summarized below:-

1. Primary repair

2. Primary repair with a proximal colostomy

3. Resection and primary anastomosis

4. Resection and anastomosis with a proximal defunction-ing colostomy

5. Exteriorisation of the perforation as a colostomy

6.    Exteriorized repair, with return of the repair

to the peritoneal cavity seven to ten days later

7.    Resection of the injured bowel, with establishment

of a proximal stoma and a distal mucous fistula.

Controversy still abounds in the management of civilian colonic

injuries (4,8,9,10,22,37,43,63).  The central debate in the operative

management is between primary repair of low risk colonic injuries

versus repair and proximal colostomy decompression.  This debate

stems from the fact that civilian injuries are secondary to low-

velocity missiles and stab wounds which cause less trauma to the

colon (4,22,25,36,41,43).  Amidst this controversy, stone and Fabian

(57), in a 1979 prospective randomized study of perforating colon

injuries, clearly demonstrated that, in selected patients, primary

repair was effective when compared with colostomy.


Primary repair

    Primary repair of selected colon injuries is becoming increa-

singly popular.  More and more series are now advocating it's

adoption, although there still remains a lack of consensus regarding

the selection criteria (4,5,6,7,8,15,18,26,30,31,36,37,39,41,47,52,54,57).

Primary repair of a colon injury involves simple closure after

meticulous debridement of the colon wound to obtain viable wall

apposition.  The repair can be performed with either a one-or two-

layer suture technique using an absorbable or permanent suture material.

Resection and anastomosis are appropriate for an injury that renders the

colon viability questionable.  The anastomosis is usually performed with a

standard two-layer or single layer closure (2, 4, 5, 6, 7, 26, 27, 39, 47, 57).

Controversy regarding the use of intraperitoneal drains in the
presence of an anatomosis continues. All surgeons would
agree that a drain placed hard up against a fresh suture line
invites disruption. At the same time, many surgeons believe
that a drain that is not in the immediate vicinity of an
anastomosis will give notice of leak without in any way being
the cause of it and will obviate generalized peritonitis
(2, 4, 6, 15, 21, 41).

Exteriorized repair

Exteriorized repair was introduced by Okies and popularized
by others (10, 28, 30, 43). It consists of debridement of the
colon  perforation with careful closure in the standard two-layer
fashion. The involved segment is then mobilized, if necessary, to
allow for exteriorization under no tension. The segment of colon
involved is exteriorized through a generous, separate incision made
through the abdominal wall parallel to the injured colon. A small
window is created in an avascular portion of the mesocolon beneath
the suture line and a fascial bridge created to support the exterio-
rized segment of colon. The peritoneum is tacked to the colon loop
with interrupted sutures to prevent small bowel herniation or
prolapse of the colon. The exteriorized loop is covered with a
transparent self-adhesive colostomy bag immediately (51).

This has the advantage of providing a warm, moist environment for the bowel, of allowing ready inspection without disturbing dressings and in the event of dehiscence, of providing a ready receptacle for faeces. The loop is inspected daily and dropped back into the peritoneal cavity with the patient under general anaesthesia approximately seven to ten days later provided there is no sign of intraperitoneal sepsis or suture line dehiscence (6, 10, 26, 30, 32, 33, 36, 43, 51, 61, 62). If leakage occurs, the loop is opened at the bedside to convert it into a loop colostomy (7, 33, 36).

## Colostomy

Colostomy has been used in the management of colonic trauma since 1795 (38), and is still a safe, conservative, acceptable method of treating such injuries (15, 26). Indication for colostomy should be gross peritoneal faecal contamination, major colonic injuries, colonic injuries associated with multiple organ injuries (particularly if they include, the liver, pancrease, or a major vessel), and the presence of heavy faecal loading (15, 31, 62). However, faecal loading can be dealt with by the use of intra-operative colonic irrigation (34) to make immediate primary anastomosis safe in the management of many distal colonic wounds. Depending upon the location of the injury, the bowel may be exteriorized as a loop colostomy or be closed and a proximal site chosen (26, 31). Proper stoma placement away from bony protuberances is essential and will facilitate patient acceptance. Care should be taken in stomal construction to avoid post-operative complications (14, 16) Viz. necrosis retraction, stenosis, and prolapse of the stoma

as well as parastomal hernia.  The formation of a proximal
colostomy necessitates a second, later operation, and certain
authors (16,18,23,38,46,50,58,62) have emphasized that the colostomy
per se is associated with signicicant morbidity and an extended
stay in hospital associated with its closure.  The colostomy should
not be closed during the same stay in hospital, but rather should be
allowed to remain for at least 6 weeks, since colostomy complications
and leakage are more frequent when closure is done early (2,14,16,21,
30,38,46).

## Wound management

By definition, wounds associated with colon injuries are contaminated
and therefore the skin and subcutaneous tissue are best left open to
heal by secondary intent or undergo delayed primary closure (26).
Wounds managed in this fashion will have the lowest infection rate
particularly if there has been massive contamination and peritonitis.
Delayed primary closure is an acceptable procedure and can generally
be performed at the bed side on the fifth post-operative day if the
wound appears clean and uninfected (7,8,10,17,21,26,31,36,46,48,54,
58,59,62).

## AFTERCARE

Patients with primary intestinal closure or closure and exteriorization
of the injured segment should be kept on nasogastric suction and
intravenous fluids until the gastrointestinal tract is completely
functional (31)

PATIENTS AND METHODS

The medical records of 45 consecutive patients treated at Kenyatta National Hospital for penetrating colonic injury between 1st January 1986 and 30th November 1992 were reviewed. This includes 33 retrospective cases seen between January 1986 and 31st December 1991, and 12 patients followed prospectively from January 1992 to November the same year. Patients with rectal injuries, and injuries that did not penetrate the colon were excluded. Also excluded from this series were those patients sustaining perforating injuries of the colon from iatrogenic causes, e.g., intraluminal foreign bodies, sigmoi-doscopic injury, and enemas.

Data collection was effected by the use of the attached proforma sheet (see appendix I for details). The sex, age, cause of injury,presence of shock, time from injury to surg-ical treatment, site of colon injury,number and location of associated injuries, presence of peritoneal contamination (based on the description of the operating surgeon), type of surgical treatment, antibiotic therapy,.and the amount of blood transfused within the initial 24 hours after injury were noted. In patients undergoing colostomy closure, post-operative length of hospitalization, interval between colostomy formation and closure, and colostomy-related morbidity was noted.

The treatment procedures were categorized into two treatment groups as outlined below:-

A.      Primary repair was defined as:

    (i)     Simple closure of the perforation(s) or

    (ii)    Resection of a segment of large bowel containing perforation(s) followed by anastomosis.

B.      Colostomy was defined as:

    (i)     Primary repair with a proximal diverting colostomy or caecostomy.

    (ii)    Resection of the injured bowel segment with establishment of a proximal stoma (ileostomy or colostomy) and a distal mucous fistula.

  (iii)   Exteriorization of the injured segment as a loop colostomy.

The technique of exteriorized primary repair with early replacement into the peritoneal cavity was not employed in any of the patients and will therefore not be considered further.

Shock was defined as being present when the blood pressure was recorded as below or equal to 90mm Hg systolic. The right colon was defined as including the caecum, ascending colon, and hepatic flexure, while the left colon was taken as comprising of the splenic flexure, and the descending and sigmoid colon. Anastomotic leakage was documented by appearance of a fistula, or was strongly suggested by the patients clinical course. The diagnosis of a wound infection was based on clinical assessment. Intra-abdominal abscess formation was documented at reoperation.

Statistical analyses were performed by the chi-square test and student's t-test.  A p value of less than 0.01 was used to identify a statistically significant difference.

## RESULTS

### Patients

There were 42 males and 3 female patients with colonic injuries, their ages ranged between 8 and 55 years (average 28.8 years).  The male-female ration was 14:1.  Thirty two patients (71.1%) underwent primary repair without colostomy. In thirteen patients (28.9%) a colostomy was constructed.

### Interval between trauma and operation

The average delay between injury and operation was 15 hours in 42 patients (range 4 to 48 hours).  Excluded from this computation were three patients whose colon injuries were initially missed at the referring hospital thus leading to delay to operation of upto 8 days.  One such case was a referral from Kajiado District Hospital sustaining retroperito- neal caecal and ascending colon perforations when he was attacked by a Warthog.  He received surgical treatment 6 days later. Another patient, referred from Kiambu District Hospital, fell from a height sustaining perforation of the hepatic flexure from blunt trauma to the abdomen.  He delayed by 8 days to operation.  The third patient was referred from Kikuyu Mission Hospital with a thoraco-abdominal stab wound.  The ensuing haemopneumothorax necessitated the insertion of a tube thoracostomy with an underwaterseal drainage.  On the fourth day after admission, faeculent discharge was noted in the thoracostomy tube prompting an exploratory laparotomy 8 days after injury.

At operation a traumatic diaphragmatic hernia was noted
with the perforated transverse colon trapped in the left
diaphragmatic rent.

Fig. 1  Bars represent number of patients within each age
group who sustained penetrating  colon injury.
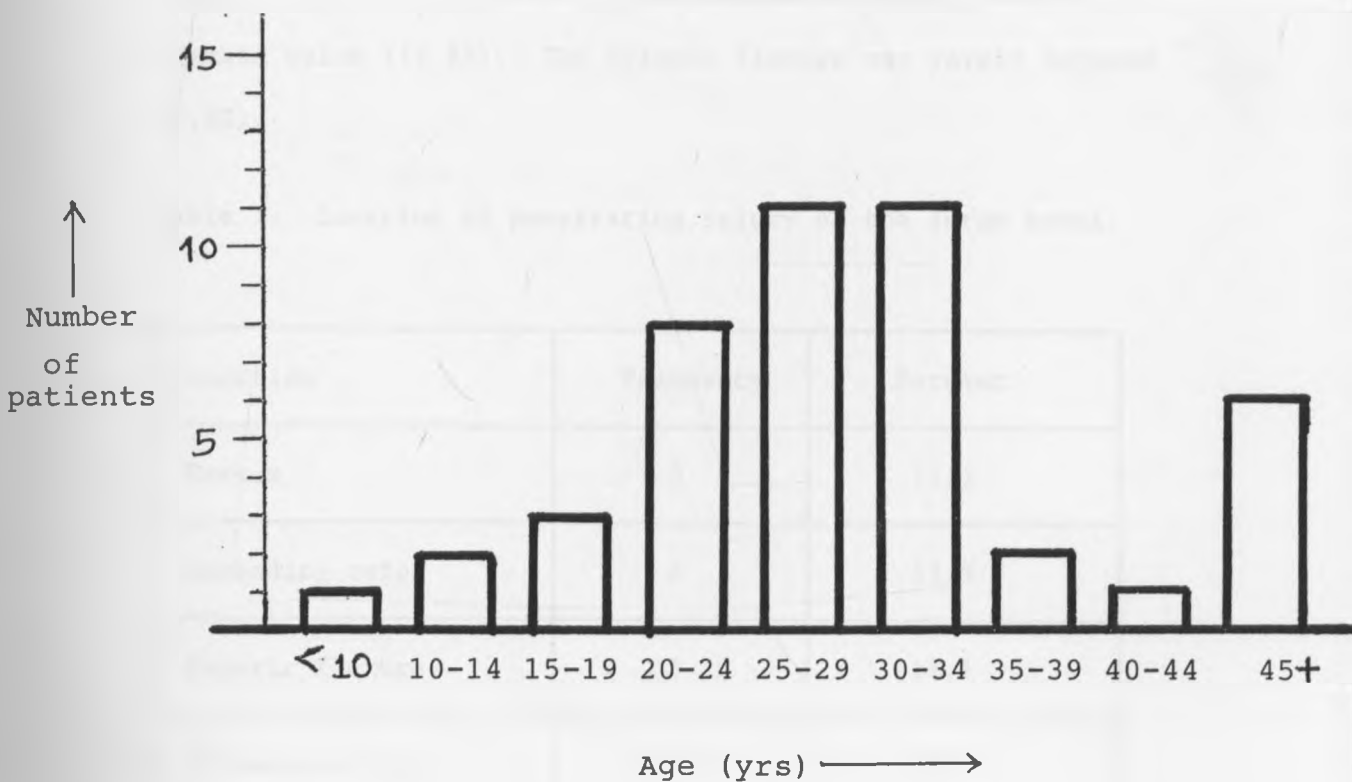


The peak incidence of colon injuries occurred in the age
group 25-29 and 30-34 yrs (Figure 1).

Mechanism of injury

Thirty patients (66.7%) sustained colon perforation
from stab wounds (inflicted by knives), eight (17.8%)
had perforations caused by gunshot wounds.  Other causes
of injury to the colon included blunt trauma in two patients
(4.4%), accidental fall on sharp objects (spear, stick, fork
jembe, gate spike) resulted in four colon perforations.  One
patient was  gored by a Warthog.

## Clinical condition on admission

Nine patients (20%) were in shock (systolic blood pressure
below or equal to 90 mm Hg) upon presentation to the ward.

## Site of Colonic injury

The transverse colon was the site most frequently injured
(Table. I).  The next most frequent area of injury was the
sigmoid colon (17.8%).  The splenic flexure was rarely injured
(2.2%).

Table I.  Location of penetrating injury of the large bowel

| Location | Frequency | Percent |
|---|---|---|
| Caecum | 5 | 11.1 |
| Ascending colon | 6 | 13.3 |
| Hepatic flexure | 5 | 11.1 |
| Transverse colon | 15 | 33.3 |
| Splenic flexure | 1 | 2.2 |
| Descending colon | 5 | 11.1 |
| Sigmoid colon | 8 | 17.8 |

Duration of Hospitalization

The average hospital stay of patients treated by primay^r closure was 13.6 days (range 3 to 55) and in those treated by colostomy 36.8 days (range 7 to 110). The length of stay for primary repair patients was significantly shorter compared to the colostomy treatment group (student's t-test, P Less than 0.01).

Table II.  Average number of Hospital days for patients with uncomplicated recoveries, wound infections, intra-abdominal abscesses, wound dehiscences, and anastomotic disruption in each treatment group.

|  | Primary repair | Colostomy |
|---|---|---|
| Uncomplicated recoveries | 7.8 | 10 |
| Wound infection | 22.5 | 48.8 |
| Intra-abdominal abscess | 30.5 | 42 |
| Wound dehiscence | 30.8 | 29 |
| Anastomotic disruption | 35 | 49.5 |

Wound infection, intra-abdominal abscess formation, wound dehiscence, and anastomotic disruption were associated with a lengthened hospital stay as compared to uncomplicated recoveries in each treatment group. The average hospital stay following wound dehiscence was similar in both groups (30.8 days versus 29 days).

Mortality

There were 2 deaths - an overall incidence of 4.4% for the series of 45 patients.  The mortality rate for gunshot wounds of the colon was 12.5% (1 death among 8 patients) as compared to a mortality rate for stab wounds of the colon of only 3.3% (1 death among 30 patients).  There was no mortality due to closure of temporary colostomies.  The two deaths were observed in the primary closure group amongst the retrospective cases and are presented below:-

CASE NO. I

Male patient 20 years of age had gunshot wound to the left lumbar region.  At admission, pulse rate was 112/min, BP 80/50 mm Hg and was moderately pale.  Delay to surgery was 36 hours. Abdominal examination revealed guarding and rebound tenderness with no audible bowel sounds on auscultation.  As surgery, one transverse colon perforation, multiple jejunal perforation and retroperitoneal haematoma were encountered.  There was no faecal peritoneal contamination.  The colon wound was repaired in two layers and the patient transfused 2 units of blood perioperatively.  Parenteral perioperative antibiotics given consisted of chloramphenical, crystapen and flagyl.  He died within the first 12 hours of operations.

CASE NO. 2

Male patient  30 years, who was stabbed in the right iliac
fossa.  He was mildly pale at admission with pulse rate 82/min.,
and BP 130/80  mm Hg.  There was no guarding or rebound tenderness
on abdominal examination.  Bowel sounds were audible on auscultation.
Delay to operation was 14 hours.  Operative findings were; one
faecal perforation, multiple terminal ileal perforations with no
reported faecal peritoneal contamination. The  caecal injury was
repaired in two layers and the peritoneal cavity drained.  He also
died within the first 12 hours of surgery.

Morbidity

The overall colon-related morbidity was 46.5% (Twenty patients
sustained 31 comlications - 19 wound infections, 6 wound dehiscence,
3intra-abdominal abscesses as well as 3 colocutaneous fistulae).
The overall morbidity was 51.2% (Twenty-two patients sustained
39 complications).  Of the three patients developing large
bowel faecal fistulae, one followed primary repair of a
perforation of the descending colon sustained from gunshot wound.
Another followed primary closure of a perforation at the hepatic
flexure.

In the third case a leak developed at the colocolic anastomosis following resection and anastomosis of the proximal transverse colon. In neither instance had a proximal colostomy been performed as a primary procedure. One patient who sustained thoraco-abdominal stabwound developed empyema thoracis. Two patients developed adhesive small bowel obstruction, one requiring surgical lysis while the other was managed conservatively.

All patients underwent primary closure of the skin and subcutaneous tissue; in 19 patients (44.2%) wound infections developed and 6 patients (13.9%) went on to develop wound dehiscence. Wound infection contributed significantly to morbidity. Only three patients out of 45 did not receive perioperative antibiotics. Two underwent primary repair of their injuries and one had a colostomy performed. All of them made an uneventful recovery. Of the patients receiving antibiotics in various combination, 11 (36.7%) went on to develop infectious complications in the primary repair group while 9 (69.2%) developed the same in the colostomy group. The overall complication rate related to performing colostomies was 38.5%. These included three instances of colostomy prolapse, one peristomal sepsis, and one colostomy necrosis. The necrotic colostomy did require revision while the other complications did not require reoperation.

Table III.  Incidence of wounding agent according to treatment.

| Operative procedure | SW | GSW | BLUNT | OTHER |
|---|---|---|---|---|
| Primary repair | 23(76.7%) | 5(62.5%) | 0 | 4(80%) |
| Colostomy | 7(23.3%) | 3(37.5%) | 2(100%) | 1(20%) |
| Total | 30 | 8 | 2 | 5 |

SW   indicates stab wounds

GSW indicates gunshot wounds

Stab wounds, by far the most common cause of colonic injury were more frequently treated by simple closure than gunshot wounds (76.7% versus 62.5% - Table III).  Gunshot wounds of the colon were more frequently treated by colostomy than stabwounds (37.5% versus 23.3%).  All the two colon injuries resulting from blunt abdominal trauma were treated by colostomy.

ASSOCIATED INJURIES

Table IV.    Site of associated injuries.

| SITE | Number of Patients |
|------|--------------------|
| Small intestine | 15 |
| Liver | 8 |
| Stomach | 7 |
| Retroperitoneal haematoma | 6 |
| Diaphragm | 4 |
| Duodenum | 3 |
| Kidney | 2 |
| Pancreas. | 2 |
| Vascular | 2 |
| Fracture femur | 2 |
| Urinary bladder | 1 |
| Fracture pelvis | 1 |
| Fracture rib | 1 |

Associated major injury involving abdominal viscera occurred
in 60% of the patients. The most frequently associated
injured organ was the small intestine (15 cases). Liver
injuries were next in frequency (8 cases), followed by
injuries to stomach, then retroperitoneal injury and diaphragm
(Table IV). Three patients sustained concomitant duodenal
injuries; associated Kidney and pancreatic injuries were
noted in two patients each.

ASSOCIATED INJURIES

Table V.   Incidence of associated intra-abdominal injuries
           according to wounding agent.

|  | 0 | 1 | 2 | 3 | 4 or more |
|---|---|---|---|---|---|
| Stab wounds | 9 | 12 | 6 | 3 | 3 |
| Gunshot wound | 1 | 3 | 2 | 1 | 1 |
| Blunt | 2 | -- | -- | -- | -- |
| Other | -- | 3 | 1 | -- | 1 |
| Total | 12 | 18 | 9 | 4 | 2 |

Thirty-three patients (73%) had associated non-colonic
intra-abdominal injury. In 12 patients the colon was the
only intra-abdominal organ injured. Such isolated colon
injury occurred   most frequently in patients sustaining stab
wounds (Table V). *A total of 18 patients had one associated
injury, 9 had two, 4 had three, while only two had four or
more associated injuries.

Gunshot wounds resulted in an average of 2.0 associated injuries whereas stab wounds had an average of 1.6 (t-test, p is less than 0.01).

No deaths occurred in those patients sustaining isolated colon injury.

Table VI.    Incidence of complications according to wounding agent.

|  | Number of patients | Number with complications(%) |
|---|---|---|
| Stab wound | 30 | 12    (40 %) |
| Gunshot wound | 8 | 7  (87.5%) |
| Blunt | 2 | 2  (100%) |
| Other | 5 | 3  (60%) |

Complications developed in 100% of patients with blunt injury, 87.5% of those with gunshot wounds, 40% of those with stab wounds, and 60% of patients sustaining colon injuries from miscellaneous causes (Table VI).

Table VII.   Treatment according to number of associated
             intra-abdominal injuries.

|  | 0 | 1 | 2 | 3 | 4 plus |
|---|---|---|---|---|---|
| Primary repair | 7 | 13 | 7 | 4 | 1 |
| Colostomy | 5 | 4 | 3 | 0 | 1 |
| Total | 12 | 17 | 10 | 4 | 2 |

Of the 12 patients sustaining isolated colon injuries, 7
had their injuries treated by primary closure while 5 underwent
colostomy formation.  Primary repair was employed more frequently
than colostomy in patients with one associated intra-abdominal
injury (Table VII).  The two patients sustaining 5 associated
intra-abdominal injuries, one had primary repair while the other
had a colostomy fashioned.  Eleven patients with two or three
associated intra-abdominal injury were treated by primary
repair compared to only three treated by colostomy.

Table VIII.  Morbidity related to associated intra-abdominal
             injuries.

|  | 0 | 1 | 2 | 3 | 4+ | Total |
|---|---|---|---|---|---|---|
| Uneventful recovery | 7 | 6 | 5 | -- | -- | 18 |
| Wound infection | 4 | 7 | 4 | 3 | 1 | 19 |
| Anastomotic leakage | 1 | 1 | -- | -- | 1 | 3 |
| Intra-abdominal abscess | -- | 2 | -- | 1 | -- | 3 |
| Death | -- | 1 | 1 | -- | -- | 2 |
| Total | 12 | 17 | 10 | 4 | 2 | 45 |

Seven patients (58.3%) out of 12 sustaining isolated colon injuries recovered without any complication whereas only 11 out of 27 patients (40.7%) sustaining one or two associated injuries made uneventful recovery (Table VIII). Wound infection occurred in 4 patients sustaining isolated colon injury as compared to 15 patients with one or more associated intra-abdominal injuries. Three cases of faecal fistulae developed in one patient with an isolated colon injury, one patient with an associated intra-abdominal injury, and one patient sustaining four associated injuries. The two deaths occurred in patients sustaining one or two associated injuries. No patient with an isolated colon injury died. Two patients with a single associated intra-abdominal injury and one with three associated injuries developed intra-abdominal abscesses. No patient sustaining isolated colon injury developed intra-abdominal abscess.

Fig. 2. Associated abdominal injury related to infectious
complications.
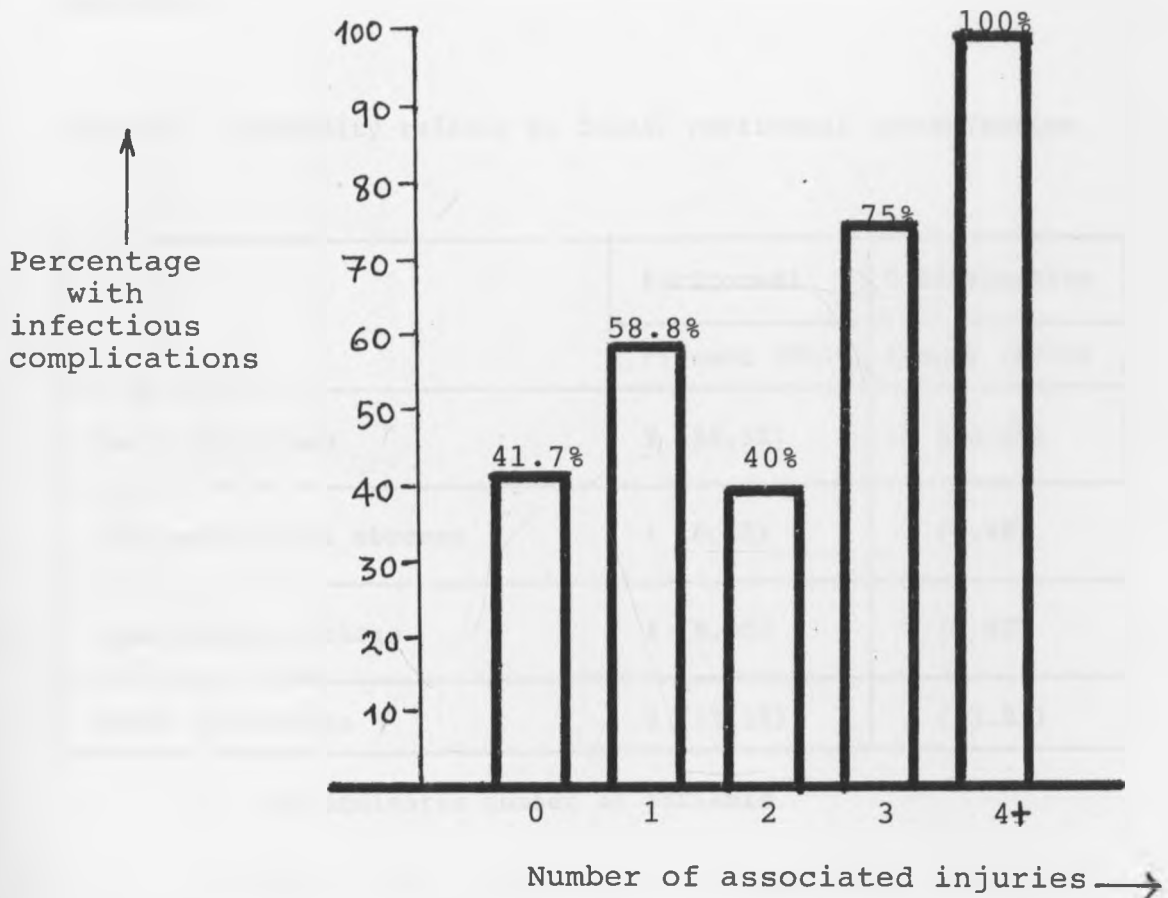


There was a general increase in the incidence of infectious
complications in relation to the increasing number of
associated injuries (Fig.2). The incidence of infectious
complications in isolated colon injuries was 41.7%. Patients
with single associated intra-abdominal injury had a 58.8%
incidence, two associated injuries had 40%, three associated
injuries had 75%, and four or more associated injuries had
100%infectious complications. The two patients who had
100% complication rate sustained colon injury from gunshot
wound and accidental fall on a sharp gate spike respectively.

In none of them was peritoneal faecal contamination
encountered at surgery. One had his colon injury treated
by primary repair while the other patient had a colostomy
fashioned.

Table IX. Morbidity related to faecal peritoneal contamination.

|  | Peritoneal | Contamination |
|---|---|---|
|  | Present (N=16) | Absent (N=29) |
| Wound infection | 9 (56.3%) | 10 (34.5%) |
| Intra-abdominal abscess | 1 (6.3%) | 2 (6.9%) |
| Anastomotic leakage | 1 (6.3%) | 2 (6.9%) |
| Wound dehiscence | 2 (12.5%) | 4 (13.8%) |

N= indicates number of patients

The rate of surgical wound infection was 56.3% in patients
who had faecal peritoneal contamination and 34.5% in those having
no faecal peritoneal contamination, a difference which was not
statistically significant (p greater than 0.5). The incidence
of Intra-abdominal abscess formation (6.3% versus 6.9%),
Anastomotic leakage (6.3% versus 6.9%), and wound dehiscence
(12.5% versus 13.8%) were similar in both patient groups
(Table IX), i.e the contaminated group and those without
faecal contamination.

Table X.    Morbidity related to delay in surgical treatment.

| | TIME INTERVAL (HOURS) | | |
| --- | --- | --- | --- |
| | Less than 8 hrs | More than 8hr | TOTAL |
| Wound sepsis | 3 (15.8%) | 16 (84.2%) | 19 |
| Intra-abdominal abscess | 1 (33.3%) | 2 (66.7%) | 3 |
| Anastomotic leakage | 1 (33.3%) | 2 (66.7%) | 3 |
| Wound dehiscence | 3 (50%) | 3 (50%) | 6 |

Eight hours was arbitrarily taken as a critical time period.   Seven patients (15.5%) were operated upon within 8 hours and thirty-eight (84.4%) later than 8 hours after injury.   Of the 38 patients delaying to operation, 26 (68.4%) were treated by primary repair and 12 (31.6%) underwent some form of colostomy.   Only one patient out of seven presenting within 8 hrs. had a colostomy performed.

Of patients developing surgical wound sepsis; three (15.8%) were operated within 8 hrs. of injury while 16 (84.2%) came to surgery more than 8 hrs. after injury (Table X).   Two patients (66.7%) operated after 8 hrs. following trauma developed intra-abdominal abscess whereas only one (33.3%) patient being operated within 8 hrs. of injury developed the same complication.   Among patients treated early, one (33.3%) developed anastomotic disruption compared to two patients (66.7%) being operated late.   This was not a statistically significant difference (p value greater than 0.1).

Wound dehiscence occurred with identical frequency
irrespective of the time interval between injury and
surgical treatment (50% versus 50%). The longer the
time interval between injury and operation the greater
was the overall risk of developing post-operative septic
complication. There were two fatalities in the delayed
group, one being operated upon 36 hours after injury
while the other was operated 14 hours following trauma.

Table XI.    Morbidity related to presence of shock at
            admission.

|                          | SBP less than or equal to 90 mm Hg (N=9) | SBP more than 90 mmHg (N=36) |
|--------------------------|------------------------------------------|------------------------------|
| Wound infection          | 9                                        | 10                           |
| Intra-abdominal abscess  | 1                                        | 2                            |
| Anastomotic leakage      | 1                                        | 2                            |
| Wound dehiscence         | 5                                        | 1                            |
|                          |                                          |                              |

SBP  indicates systolic blood pressure

N    denotes number of patients

All the nine patients presenting in shock went on to
develop surgical wound sepsis while 27% of the normotensive
patients developed wound sepsis (10 patients among 37).
Hypotension was associated with subsequent anastomotic
leakage in one patient (11.1%), while only two patients
(5.4%) who remained normotensive developed anastomotic
disruption (Table X1).  One patient (11.1%) in shock
at admission developed intra-abdominal abscess compared
to two patients (5.4%) with normal blood pressure.  The
rate of wound dehiscence was higher in the patients
in shock than those with a normal blood pressure (55.5%
VERSUS 2.7%).

Blood transfusion requirements

In 17 patients, a blood transfusion was required during
the initial procedure.  Of the 14 patients receiving
one or two units of blood, one had anastomotic leakage
(7.1%).  No patient given three or more units of blood
had anastomotic disruption.  Two patients among 26 (7.7%)
who were not transfused developed anastomotic leakage.
Intra-abdominal abscess   developed in three patients,
one did not receive any transfusion, the second received
more, than three units of blood.  Wound sepsis was observed
in 9 patients (64.3%) receiving 1-2 units, and 2 patients
(66.7%) of the three patients receiving more than 3
units of blood.

Fig. 3.   The relationship between infectious complications and
blood transfusion requirements.
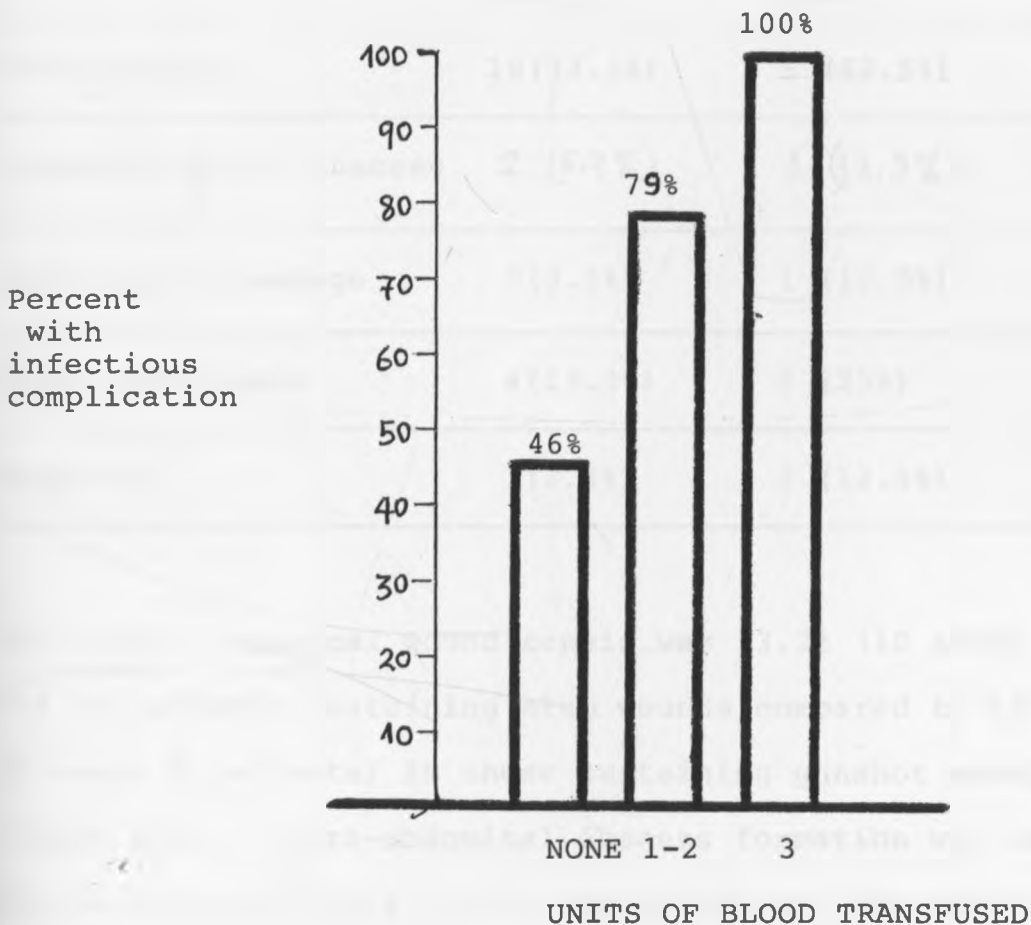


The incidence of infectious complications in patients receiving
no transfusion was 46%, those receiving 1 or 2 units had
79%, and all the three patients receiving more than 3 units of
blood had infectious complications for an 100% incidence
(figure 3).

AGE

No relationship was demonstrated between the incidence
of morbidity and patients age.  The patients in the age
group under 20 years had  8 complications, 20 - 30 years had
15 complications, and 31-40 years had 8 complications.
There was no complications occuring in the age group over
41 years.

Table XII.  Morbidity related to cause of colon  injury.

|  | STAB WOUND (N=30) | GUNSHOT WOUNDS (N=8) | OTHER (N=7) |
|---|---|---|---|
| Wound sepsis | 10(33.3%) | 5 (62.5%) | 4(57.1%) |
| Intra-abdominal abscess | 2 (6.7%) | 1 (12.5%) | — |
| Anastomotic leakage | 1(3.3%) | 1 (12.5%) | 1(14.3%) |
| Wound dehiscence | 4(13.3%) | 2 (25%) | --- |
| Mortality | 1(3.3%) | 1 (12.5%) | --- |

The rate of surgical wound sepsis was 33.3% (10 among
30) in patients sustaining stab wounds compared to 62.5%
(5 among 8 patients) in those sustaining gunshot wounds
(Table XII).  Intra-abdominal abscess formation was observed
in two patients (6.7%) with stab wounds and one patient
(12.5%) with gunshot wound.  The rate of wound dehiscence
was not significantly higher in gunshot wounds than stab wounds

(25% versus 13.3% chi-square test, p greater than 0.5).
One patient with stab wound developed anastomotic disruption
for an incidence of 3.3% while one with gunshot   wound
had anastomotic disruption for an incidence of 12.5%.


Table XIII.     Morbidity related to site of injury.

|  | RIGHT COLON (N=16) | TRANSVERSE COLON (N=15) | LEFT COLON (N=14) |
|---|---|---|---|
| Wound sepsis | 9(56.3%) | 5(33.3%) | 5(35.7%) |
| Intra-abdominal abscess | 2(12.5%) | 1(20%) | --- |
| Anastomotic leakage | 1(6.3%) | 1(6.7%) | 1(7.1%) |
| Wound dehiscence | 2(12.5%) | 2(13.3%) | 2(14.3) |
|  |  |  |  |

N   indicates number of patients

Sixteen patients (35.6%) had right colon injuries, 15(33.3%)
had transverse colon, and 14 (31.1%) had left colon
involvement.  The incidence of wound infection among
patients with right colon injuries was 56.3% compared
to 35.7% among the left colon group (Table XIII).  Two
patients (12.5%) developed intra-abdominal abscess in
the right colon group, as opposed to none in the group
with left sided injuries.  The rates of anastomotic leakage
and wound dehiscence were similar in the right and left
colon injury groups (Table XIII).

Fig. 4. Bar chart showing the relationship between
Single and multiple colon injury with reference to
percentage with complications (wound sepsis, intra-
abdominal abscess and anastomotic leakage).



KEY
☐ SINGLE INJURY
▥ MULTIPLE INJURY
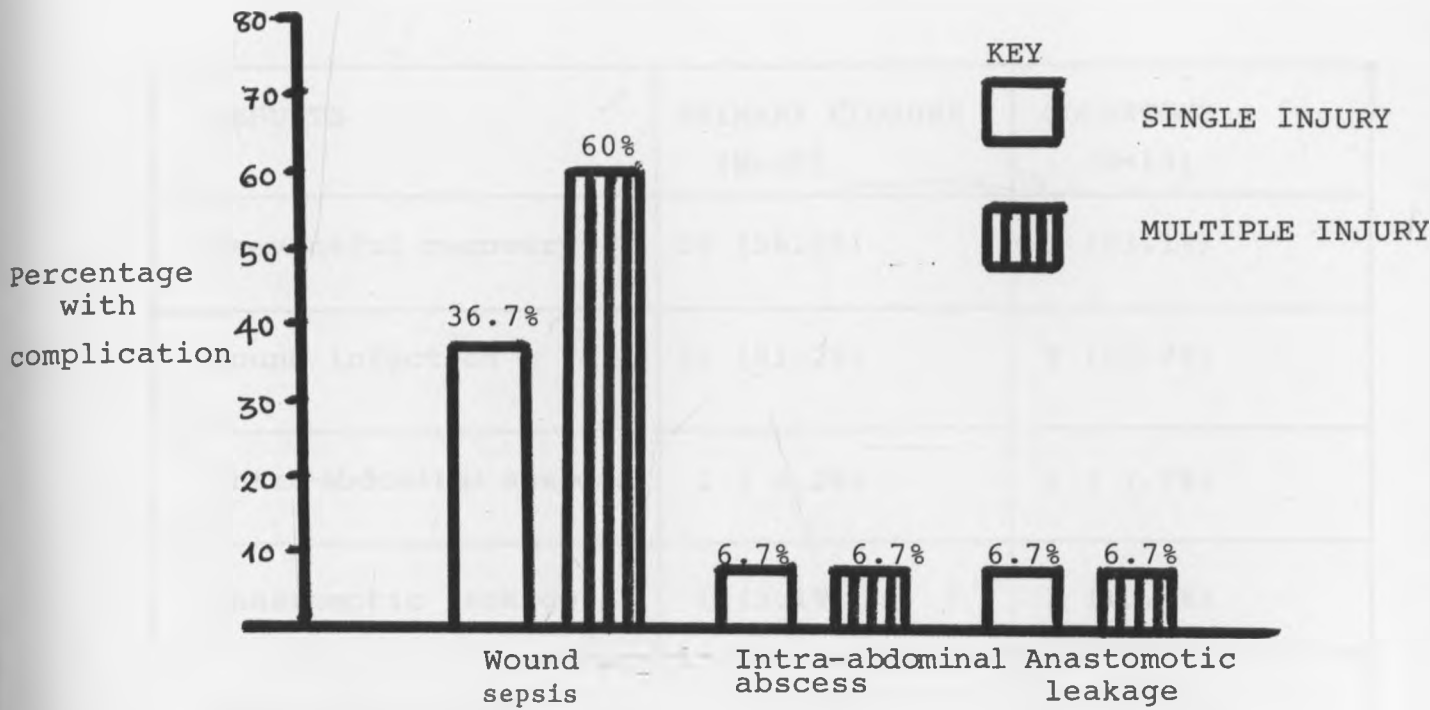
Thirty patients (66.7%) had single perforations and fifteen patients
(33.3%) had multiple colon perforations. Two fatalities occurred in
the single perforation group and none in the other colon injury
group. The incidence of wound sepsis was 36.7% in patients with
single perforation compared to 60% in the multiple colon perforation
group (Fig. 4). The incidence of intra-abdominal abscess formation
(6.7%) and anastomotic leakage (6.7%) was observed to be identical
in both single and multiple perforation groups.

Table XIV.  Comparison of post-operative morbidity between
primary closure and colostomy.

| RESULTS | PRIMARY CLOSURE (N=32) | COLOSTOMY (N=13) |
|---|---|---|
| Uneventful recovery | 18 (56.2%) | 3 (23.1%) |
| Wound infection | 10 (31.2%) | 9 (69.2%) |
| Intra-abdominal abscess | 2 ( 6.2%) | 1 ( 7.7%) |
| Anastomotic leakage | 1 (3.1%) | 2 (15.4%) |
| Wound dehiscence | 4 (12.5%) | 2 (15.4%) |
| Colostomy problems | N/A | 5 (38.5%) |
| Intestinal obstruction | 1 | 1 |
| Deaths | 2 (6.2%) | -- |

N/A  denotes not applicable.

As indicated in table XIV above, eighteen patients (56.2%) of the thirty-two who had primary closure had an uneventful recovery while only three (23.1%) of the thirteen who had colostomy had an uneventful recovery.  Two deaths occurred in the primary repair group while none was observed in the colostomy group.  Wound infection occurred with a higher frequency in those patients treated by colostomy than by primary repair (69.2%  versus 31.2%).  The incidence of anastomotic leakage was higher in the colostomy group than primary closure group (15.4%  versus 3.1%), though this was not statistically significant.  The rates of wound dehiscence and intra-abdominal abscess formation were similar in both treatment groups (15.4%  versus 12.5%, and 7.7% versus 6.2%).

## COLOSTOMY CLOSURE

In this series of patients, 6 have not undergone colostomy closure.  At present, 4 await elective colostomy closure while 2 patients have been lost to follow-up study.  7 patients having colostomy underwent closure with a morbidity (wound infection) rate of 28.6%  and no mortality.  The interval from formation to closure of the colostomy ranged from 24 days to 9 months with an average of 118.4 days and median of 99 days.  The average post-operative stay following colostomy closure was 8.1 days (range 4 to 19 days).  The patient who stayed for 19 days had wound infection.

Table XV.   Primary closure morbidity versus colostomy morbidity
in relation to presence or absence of shock.

|  | Hypotension (N=9) | | Normotension (N=36) | |
| --- | --- | --- | --- | --- |
|  | Primary closure | Colostomy | Primary closure | Colostomy |
| Wound sepsis | 5(55.5%) | 3(33.3%) | 5(13.9%) | 6(16.7%) |
| Intra-abdominal abscess | 1 | - | 1(2.8%) | 1(2.8%) |
| Faecal fistula | - | 1 | 1 | 1 |
| Wound dehiscence | 4(44.4%) | 1(11.1%) | - | 1 |
| Death | 1 | - | 1 | - |

Hypotension is systolic blood pressure below or equal to
90 mm Hg.
Normotension is systolic blood pressure above 90 mm Hg
N denotes number of patients.

The incidence of wound sepsis was 55.5% in the primary closure
group and 33.3% in the colostomy construction group in patients
presenting in shock.  For normotensive patients the incidence of
wound sepsis was similar amongst the two treatment groups (13.9%
vs. 16.7% - Table XV).  One patient presenting in shock and
undergoing primary closure of his colon injury developed intra-
abdominal abscess while none was observed in the colostomy
treatment group.  The incidence of wound dehiscence amongst
patients in shock was  44.4% for primary closure group and 11%
for primary closure group and 11.1% for the colostomy construction
group.  The incidences of faecal fistula and intra-abdominal abscess
formation was identical for the two treatment groups - 2.8% each
for the normotensive patients.

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Table XVI.  Comparison of morbidity between primary closure and
colostomy in relation to time from injury to operation.

| | Less than 8 hrs (N=7) | | More than 8 hrs (N=38) | |
|---|---|---|---|---|
| | Primary closure | Colostomy | Primary closure | Colostomy |
| Wound sepsis | 3(42.8%) | 2(28.6%) | 8(21%) | 7(18.4%) |
| Intra-abdominal abscess | 1 | - | 1(2.6%) | 1(2.6%) |
| Faecal fistula | - | 1 | 1 | 1 |
| Wound dehiscence | 3(42.8%) | 1(14.3%) | 1 | 1 |

        In patients treated within 8 hours of injury, the incidence
of surgical wound sepsis was almost one-and-a-half times more
frequent in the primary closure than the colostomy treatment group
(42.8% vs 28.6% - Table XVI).  No faecal fistula occurred in patients
being treated by primary closure of the colon wound within 8 hours.  In
patients undergoing operative treatment after 8 hours of injury, the
incidences of wound sepsis was similar in the two groups (21% vs
18.4%).  The incidences of faecal fistula and intra-abdominal abscess
formation were identical in the primary closure and colostomy
construction groups (2.6% vs 2.6%).  One patient undergoing primary
repair of the colon injury within 8 hours developed intra-abdominal
abscess while none having colostomy construction developed this
complication.

## DISCUSSION

General characteristics of this study population are similar to other series, but notable for a high percentage of stab wounds causing colonic trauma. Stab wounds accounted for 30 cases (66.7%) while gunshot wounds caused trauma to the colon in only 8 cases (17.8%). This observation is in keeping with reports emanating from South Africa (2, 15, 50, 51), and West Indies (39). Reported series from Industrialized countries demonstrate that gunshot wounds are the predominant cause of penetrating trauma to the colon (1, 6, 7, 9, 12, 17, 18, 25, 47). This discrepancy may be explained on the basis of availability of firearms; whereas legislation is very strict on acquisition of these in developing countries it is quite liberal in the Western world.

In this study, males were injured more often than females and the male-female ratio. was 14:1. This is comparable to that quoted in the series published elsewhere (2, 8, 9, 48, 50, 51, 54 59). The males are more violence prone than females. Most colon injury patients are young males with injuries resulting from gunshot or stab wounds. The mean age of patients in this series was 28.8 years which compares well with that of other series (2, 3, 6, 9, 12, 47, 63). The peak incidence of colon injuries was observed in the age group 25-29 and 30 - 34 years which reinforces the above statement that majority of colon injury occur in young individuals (Fig. 1).

Stab wounds apparently were benign type of injuries as exemplified below. Most isolated colon injuries resulted from stab wounds than gun-shot wounds (30% vs. 12.5%, Table V). In 40% of patients, stab wound resulted in two or more associated injuries whereas gunshot wounds resulted in two or more associated injuries in 50% of patients.

In other words, stab wounds had an average of 1.6 associated
injuries whereas gunshot wounds had an average of 2.0, a difference
which was statistically significant (t-test, p less than 0.01).
Stab wounds resulted in 12 (40%) complications while gunshot wounds
and blunt trauma resulted in 7 (87.5%) and 2 (100%) complications res-
pectively (Table VI). The majority of stabwounds (23 cases) were
treated by primary repair compared to only 5 cases of gunshot wounds.
No patient sustaining colonic injury from blunt trauma was treated
by primary closure (Table III).

The transverse colon was the site most frequently injured (Table I).
Being suspended on a long mesentery, it may assume any position within
the peritoneal cavity, and therefore may be injured more frequently
than the other relatively fixed parts. Almost two-thirds of patients
sustaining perforating colon injury had an associated major injury
involving abdominal viscera. The small intestine (15cases) was the
commonest associated injury followed by the Liver (8cases) and
stomach (7cases) (Table IV).

## Mortality

The over-all mortality rate of 4.4% in the present series, is
comparable to around 10% or less reported for penetrating colon
trauma (1,5,6,7,9,15,18,30,54,59,63). The relatively low mortality
rate observed may be due to the fact that the majority of these
injuries were caused by stabwounds. Considering the mechanism of
injury, gunshot wounds had a higher mortality rate than stab wounds
(12.5% Vs 3.3%). Mortality following colonic injury is related to the
number and severity of the concomitant injuries (6,41).

Gunshot wounds commonly produce injuries to multiple sites within the colon as well as damage to other organs within the pritoneal cavity (31, 44, 47).  The prognosis is worse in those patients  who have several abdominal organs wounded, especially the pancreas, duodenum and liver (26, 52).

Morbidity

The present series of 45 cases had a 40% colon related morbidity which compares well with the 44% reported by Yaw et al (63), and 59% reported by Robbs et al (50).  Surgical wound infection contributed significantly to the high morbidity noted, with 44.2% of the patients developing it.  The likely explanation is that all the patients underwent primary closure of the surgical wound immediately after surgery even in the presence of grss faecal peritoneal contamination.  The overall incidence of anastomic leakage and inta-abdominal abscess formation were 6.7% each.  Surgical wound disruption occurred in 6 patients for an overall incidence of 13.3%.

In general the rate of infectious complications in patients treated by colostomy construction was almost double that observed in primary repair group (69.2% vs. 36.7%).  This may be due to increased chances of peritoneal or surgical wound contamination during colostomy formation especially in extensive intraluminal faecal loading of the colon.

Risk factors

In previous published report by Beall (4), Dawes (12),
Demetriades (15), Huber (26), Robbs (50), Shannon (54), and their
associates, several clinical features were found to be correlated with
poor results after treatment of trauma to the colon. These includes
shock, the type of wounding agent, large transfusion requirement,
contamination, multiple injuries, advanced age, extent of the colon
injury, and delay from the time of injury to that of operation (6, 7,
17).

It has been stated that increasing morbidity following large bowel
injury is directly proportional to the presence of associated injury
(12, 26, 50, 52). This was confirmed by the data in this study. There
was a general increase in the incidence of infectious complications
in relation to the increasing number of associated injuries (Fig. 2).

The number of associated injuries provides not only a measure of
the severity of the traumatic insult but is also related to the like-
lihood of developing infectious complications after colon injury
(13, 40, 54). This series also confirms that the mortality among
patients with large bowel injury is related to the number of associa-
ted injuries. In fact, in the present series there were no deaths
amongst those patients who had an isolated colonic injury (Table VIII).
Isolated colon injuries had 33.3% wound infections, one associated injury
had 41.2%, two associated injuries had 40%, and three or more associated
injuries had 75% incidence of wound infection. Only patients with
one or more associated intra-abdominal injuries had intra-abdominal
abscess formation.

Faecal contamination of the peritoneal cavity significantly affected the morbidity rate with regard to the incidence of wound sepsis. Patients with faecal peritoneal contamination at operation, exhibited a higher rate of surgical wound sepsis than the no contamination group (56.3% vs. 34.5% - Table IX). It would seem that the presence of faeces in the peritoneal cavity has considerable bearing on the results of wound management. There was no significant difference in the incidences of intra-abdominal abscess formation, anastomotic leakage, and wound dehiscence between the patients with peritoneal contamination and those without. Wound dehiscence in particular is determined by the technique of wound closure and not potential contamination.

The majority (84.4%) of patients in this study were operated upon later than 8 hours after injury. This may be the reason for the high overall morbidity observed. A delay of more than 6 hours has been associated with increased infection after colon trauma. Although not statistically significant, the incidence of surgical wound sepsis, intra-abdominal abscess formation, and anastomotic leakage were higher in the delayed group than patients treated within 8 hours of injury (Table X). This may be due to prolonged contamination resulting in established infection. Identical wound dehiscence rates was observed between those delaying to operation and those being operated upon within 8 hours of injury (50% vs 50%). This reinforces the earlier assertion that wound dehiscence may be an end result of poor technique of wound closure.

In this study, the presence of shock was associated with a higher incidence of morbidity than normotension (Table XI). Surgical wound sepsis rate was three-and-a-half times more frequent in patients in shock at admission than those who remained normotensive (100% vs. 27%).

The incidence of anastomotic leakage and intra-abdominal abscess formation were twice as frequent in hypotensive patients as in normotensive ones. Other reports examining colon injuries have emphasized the importance of shock in predisposing a patient to postoperative infection (17, 28, 52). Hypotension may also induce sustained reductions in bowel perfusion with consequent anastomotic dehiscence and spontaneous colon necrosis (54). Five patients (55.5%) in shock at admission went on to develop wound dehiscence as compared to only one (2.7%) normotensive patient. Shock plays a role in subsequent wound complication due to poor tissue healing as a consequence of diminished peripheral tissue perfusion.

Transfusion requirement was a predictive factor for subsequent infection. There was an increased incidence of infectious complications with increasing blood transfusion requirement (Fig. 3). Although transfusion requirement and the occurrence of shock are linked, the former indicates an increased risk of infection more accurately than does the latter (13, 40).

Although morbidity analysis in this study did not find the association between increasing age and the risk of infection to be significant, Nichols et al (40) and Dellinger et al (13) have found that age is an important predictor of risk of infection in patients with penetrating abdominal trauma. This observation has also been corroborated by other investigators who have looked at colon injury (6, 12, 28, 63). Most of the patients in this series were young, being under the age of 35 years.

Patients sustaining ballistic wounds tend to have more
serious injury, conversely, stab wounds generally produce less
severe injury (26, 44, 47). In this series, patients sustaining
colon injuries from gunshot wounds tended to have other injuries
more often than did those with stab wounds, and morbidity and
mortality were higher (Table XII). Patients sustaining gunshot
wounds demonstrated almost double the incidence of wound sepsis and
intra-abdominal abscess formation as compared with stab wound. The
rate of anastomotic leakage and the incidence of mortality was
four times greater in gunshot injuries than stab wounds. The rate
of wound dehiscence was not significantly higher in gunshot injuries
than stab wounds (25% vs. 13.3% - Chi-square test, P is greater
than 0.5).

The locations of the colon perforations were evenly distributed
throughout the length of the colon, with 16 perforations located
in the right colon, 15 perforations located in the transverse colon,
and 14 perforations in the left colon (Table XIII). The incidence
of colon-related complications in cases with right colon injuries
treated by primary repair appeared to be greater than that of left colon
injuries treated similarly, although the difference was not
statistically significant (50% vs. 33%, P greater than 0.01). The
incidence of complications in the right colon injuries treated by
colostomy (100%) was apparently higher than that in left colon injuries
treated similarly (78%). In general the right colon injuries had a
higher rate of wound sepsis and intra-abdominal abscess formation

than left colon injuries (Table XIII).  This may be due to greater degree of fecal contamination with the right colon injuries since the right colon contents are liquid while the left colon contents are solid. The incidence of anastomotic leakage and wound dehiscence in left colon injuries was not different from that in right colon injuries treated similarly (Table XIII).  Thompson et al (59) demonstrated that right-sided colon injuries do not behave more favorably than left-sided injuries, and that despite the anatomic and physiologic differences, both should be managed similarly.  The data in this study supports this assertion.

There was no difference in the incidence of intra-abdominal abscess formation and anastomotic leakage when single colon injury was related to multiple injuries (fig.4).  The surgical wound infection rate tended to be higher in the multiple colon injury group (60%) than in single colon injury patients (36.7%).  This may be due to a greater extent of faecal contamination with multiple colon perforations.

Primary colon repair was accomplished in 71% of cases with a 36.7% morbidity and 6.3% mortality.  The relatively low morbidity and mortality incurred attests to the safety of this procedure.  The two fatalities occurred within the first 24 hours and may not have been related to the colon repair per se.  The rate of colostomy construction was 29% with a morbidity of 69.2% and no mortality.  The morbidity rate for colostomy is usually reported as around 20 - 30% (12, 17, 18, 23, 50). The mortality rate directly related to the colostomy is about 1% (14). The hospital stay was shortest for patients undergoing primary repair

and longest for patients having colostomy construction (13.6 vs. 36.8 days, student's t-test, P less than 0.01). Table II compares the average number of hospital days between primary repair and colostomy in relation to morbidity. Surgical wound infections and anastomotic disruptions were most frequent with colostomy construction in this series (Table XIV). The chance of wound sepsis occurring in patients treated with colostomy was twice that in patients treated with primary repair (69.2% vs. 31.2%). There was no difference in the incidence of wound dehiscence and intra-abdominal abscesses noted between the two treatment groups. The foregoing discussion gives the impression that patients in whom colon wounds were primarily closed did well, and spent a considerably shorter period in hospital than those in whom colostomy was performed.

The reported complication rates for colostomy closure have ranged from 10 - 44% (10, 12, 18, 38, 58, 62). The mortality rate has been reported to be from 0 - 3% (10, 12, 38, 58, 62). In the present study, patients who had colostomy closure developed morbidity of 28.6% and no mortality. This observation is similar to that of other studies reported in the literature (62). In addition to the morbidity rate of colostomy closure, the added time of hospitalization must be evaluated. The average hospitalization for patients undergoing closure in this series was 8.1 days (range 4 to 19 days). The safest time to close a colostomy created for trauma is between six weeks and three months (16, 38, 46). The patients undergoing colostomy closure in the present study did so between three weeks and nine months after construction. None of them developed faecal fistula.

In normotensive patients, wound sepsis, faecal, fistula and intra-abdominal abscess formation occurred with similar incidences between the primary repair and colostomy treatment groups. For patients in shock, the primary closure group had higher incidences of wound sepsis and dehiscence than the colostomy group. Colostomy construction therefore appears safer in the presence of shock (Table XV).

The general trend of results in the present series shows that colostomy construction has less morbidity in terms of surgical wound sepsis, intra-abdominal abscess and wound dehiscense when compared with primary repair (Table XVI) in patients treated within 8 hours of injury. However, in patients delaying to surgery beyond 8 hours no single treatment mode is superior to another.

CONCLUSIONS

This study indicates that:

1. Most colon injury patients in our set up were young males with injuries
mainly resulting from stabwounds though a small proportion was caused
by gunshot wounds.

2. Patients sustaining colon injury from gunshot wounds had other injuries
more often  than did those with stab wounds, and therefore the mortality
and morbidity were greater.

3. The overall mortality rate of penetrating colon· injury was 4.4% while
the morbidity rate was 46.5%, with surgical wound sepsis contributing
significantly to the high morbidity.

4. The risk factors for the development of postoperative septic
complications (and therefore increased morbidity) were; presence of
associated injuries, faecal contamination, delay to surgical treatment
of more than 8 hours, presence of shock at admission, increasing transfusion
requirement, and multiplicity of colon injury.  There was no correlation
between increasing age and the risk of infectious  complications.

5. The patients in whom colon perforations were primarily closed did well,
and spent a considerably shorter period in hospital than those in whom
colostomy was performed.  Colostomy formation and closure had prohibitive
morbidity.

6.    The overall incidence of surgical wound dehiscence (13.3%),

faecal fistula (6.7%), and intra-abdominal abscesses

(6.7%) were low and well within the accepted margins for a

contaminated procedure.

7.    The general pattern of results indicates that injuries to

the right colon are not more favorable than those of the

left.  Penetrating trauma to the right and left colon should

thus be managed similarly.

## RECOMMENDATIONS.

Generally colostomy is considered as the safest method

of treatment of a colonic injury.  Although this may be true

for certain injuries where suture line leak is likely, it

is believed that colostomy has been over used.  A colostomy

is an open source of contamination, very close to an incision

and with a possible communication with the abdominal cavity

through its abdominal wall exit.  Theoretically it should be

associated with a higher incidence of wound sepsis and intra-

abdominal abscesses.  Furthermore it is associated with longer

hospital stay than after primary repair and the patients have

to be subjected to the inconvenience and risks of another operation

for colostomy closure, a procedure with significant morbidity.

Primary repair is safe when performed in the proper setting.

It should be the mainstay for the treatment of stab wounds

(a predominant cause of civilian colon injuries in our set up).

The best results will be achieved in those patients in whom

the effects of peritoneal contamination are reduced to a

minimum by rapid admission to hospital, prompt resuscitation, early administration of antibiotics (that are effective against both the aerobic and anaerobic gastrointestinal tract flora), and prompt surgical repair for the injuries.

Colostomy remains the standard procedure for complicated colon injuries. It is recommended for those who are deemed high-risk patients with multiple associated injuries, gross peritoneal contamination, protracted shock, delay of more than 8 hours from injury to operation, and severe and multiple colon injuries. To this end gunshot wounds of the colon should be managed by formation of a colostomy.

Since wound sepsis contributed significantly to morbidity in this study, it is recommended that all patients with penetrating colon trauma the skin and subcutaneous tissue should not be closed primarily at the initial operation but is dealt with by delayed primary closure at about the fifth day if the wound remains clean or allowed to heal by secondary intent. In summary the following management policy of colon injury at KNH are recommended.

1) Patients sustaining penetrating colon injury should be rapidly admitted to hospital and promptly operated within 8 hours of injury.

2) Patients sustaining isolated colon injury especially from stab wounds should undergo primary repair of the colon wound provided the patient is treated within 8 hours, is normotensive and has no peritoneal faecal contamination and receives appropriate antibiotics.

3) Patients seen beyond 8 hours of injury, or in shock, or with more than two associated intra-abdominal injuries, and/or having heavy peritoneal contamination should undergo colostomy construction to minimize morbidity.

4) In patients with penetrating colon injury, it is advisable that the skin of the Laparotomy wound should not be closed primarily but left open to be treated by delayed primary closure or secondary closure.

5) Gun shot wounds of the colon should be managed by colostomy construction.

REFERENCES

1.  Arango A, Baxter C, Shires GT: Surgical management of
    traumatic injuries of the right colon; Twenty years of civilian
    experience. Arch. Surg. 114: 703 - 706, 1979.

2.  Baker LW, Thomson SR, Chandwick SJD. Colon wound management
    and prograde colonic lavage in large bowel trauma. Br. J.
    Surg. 77 : 872 - 876, 1990.

3.  Bartzial JF, Boyd DR, Folk FA, et al. Critical review of
    management of 392 colonic and rectal injuries. Dis. Colon.
    Rectum 17: 313 - 318, 1974.

4.  Beall AC, Bricker DL, Alessi FJ, et al. Surgical considerations
    in the management of civilian colon injuries. Ann Surg. 173 :
    971 - 978, 1971.

5.  Bugis SP, Blair P, Letwin ER. Management of blunt and
    penetrating colon injuries. Am. J. Surg. 163: 547 - 550, 1992.

6.  Burch JM, Brock JC, Gevirtzman L, et al. The injured colon.
    Ann. Surg. 203 (6) : 701 - 711, 1986.

7.  Burch JM, Martin RR, Richardson RJ, et al. Evolution of the
    treatment of the injured colon in the 1980s. Arch. Surg. 126 :
    979 - 983, 1991.

8.  Chappuis CW, Frey DJ, Dietzen CD, et al. Management of
    penetrating colon injuries; A prospective randomized trial.
    213(5) : 492 - 497, 1991.

9.  Cook A, Levine BA, Rusing T, et al. Traditional treatment
    of colon injuries; An effective method. Arch. Surg. 119 :
    591 - 594, 1984.

10.  Dang CV, Peter ET, Parks SN, et al.  Trauma of the colon;
     Early drop-back of exteriorized repair.  Arch. Surg. 117 :
     652 – 656, 1982.

11.  Davey WW. Abdominal injuries.  In Adelola Adeloye (ed). Davey's
     companion  to surgery in Africa, second ed. 1987.  Churchill
     Livingstone. Ch. 33 : 406 – 411.

12.  Dawes LG, Aprahamian C, condon RE, et al.  The risk of infection
     after colon injury.  Surg. 100(4) : 796 – 803, 1986.

13.  Dellinger EP, Oreskovich MR, Wertz MJ, et al.  Risk of infection
     following Laparotomy for penetrating abdominal injury.  Arch.
     Surg.  119 : 20 – 27, 1984.

14.  Delvin HB. Colostomy : Indications, management and complications.
     Ann. Roy. Coll. Surg. Engl. 52 : 392 – 408, 1973.

15.  Demetriades D, Rabinowitz B, Safianos C, et al.  The management
     of colon injuries by primary repair or colostomy.  Br. J. Surg.
     72 : 881 – 883, 1985.

16.  Doberneck RC. Revision and closure of the colostomy.  Surg.
     Clin. North Am.  71(1): 193 – 201, 1991.

17.  Flint LM, Vitale GC, Richardson JD, et al.  The injured colon;
     Relationships of management to complications.  Ann. Surg.
     193(5) : 619 – 623, 1981.

18.  Garfinkle SE, Cohen SE, Matolo NM, et al. Civilian colonic
     injuries : Changing concept of management.  Arch. Surg. 109:
     402 – 404, 1974.

19.  Gentry LO, Feliciano DV, Lea AS, et al.  Perioperative antibiotic therapy for penetrating injuries of the abdomen.  Ann. Surg. 200 : 561 – 566, 1984.

20.  Goldberg SM, Nivatvongs S, Rothernberger DA. Colon, Rectum and Anus.  In Schwartz SI, and others (eds). Principles of surgery 5th ed. Mc Graw-Hill book company, 1989. Ch. 28. pp 1225 – 1227.

21.  Hanna SS, Jirsch DW. Management of colonic and rectal injuries. Can. Med. Assoc. J. 120 : 1387 – 1391, 1979.

22.  Haynes CD, Gunn CH, Martin JD. Colon injuries.  Arch. Surg. 96 : 944 – 948, 1968.

23.  Hines  JR, Harris GD. Colostomy and Colostomy Closure.  Surg. Clin. North  Am. 57(6) : 1379 – 1392, 1977.

24.  Holy Bible : Judges, chapter 3, Verses 21 – 22, Revised Berkeley Version. 1974 edition.

25.  Hoyt DB, Markersie RC. Abdominal injuries.  In Cuschieri A, Giles GR, Moosa AR, (eds).  Essential surgical practice.  2nd ed.  Wright. Chapter 19. pp 291 – 304, 1988.

26.  Huber PJ, Thal ER. Management of colon injuries.  Surg. Clin. North AM. 70(3) : 561 – 573, 1990.

27.  Josen As, Ferrer JM, Forde KA, et al.  Primary closure of civilian  colorectal wounds.  Ann. Surg. 176 : 782 – 786, 1992.

28.  Karanfilian RG, Ghuman SS, Pathak VB, et al. Penetrating injuries to the colon.  Am. Surg. 48 : 103 – 108, 1982.

29.  Kester DE, Andrassy RJ, Aust JB.  The value and cost effectiveness of abdominal roentgenograms in the evaluation of stab wounds to the abdomen. Surg. Gynecol.  Obstet.  162 : 337 – 339, 1986.

30. Kirkpatrick JR, Rajpal SG.  The injured colon:  Therapeutic considerations.  Am. J. Surg. 129: 187 – 191, 1975.

31. Kirkpatrick JR, Injuries of the colon. Surg. Clin. North AM. 57 : 67 – 76, 1977.

32. Kirkpatrick JR, Rajal SG.  The management of penetrating wounds of the colon.  Surg. Gynecol.  Obstet, 137 : 484 – 486, 1973.

33. Kirkpatrick JR. The exteriorized anastomosis; Its role in surgery of the colon.  Surg. 82 : 362 – 365, 1977

34. Koruth NM, Krukowski HZ, Youngson GG, et al.  Intra-operative colonic irrigation in the management of Left-sided large bowel emergencies.  Br. J. Surg. 72 : 708 – 711, 1985.

35. Last RJ, Topographical anatomy of the alimentary canal.  In Anatomy: Regional and Applied.  7th ed. ELBS, 1984. pp 291 – 297.

36. Lou MA, Johnson AP, Atik M, et al.  Exteriorized repair in the management of colon injuries.  Arch. Surg. 116: 926 – 929, 1981.

37. Lucas CE, Ledgerwood AM.  Management of the injured colon. Current surgery. 43(3) : 190 – 193, 1986.

38. Machiedo GW, Casey KF, Blackwood JM: Colostomy closure following trauma.  Surg. Gynecol. Obstet. 151 : 58 – 60, 1980.

39. Naraynsing V, Ariyanayagam D, Pooran S:  Primary repair of colon injuries in a developing country.  Br. J.  Surg. 78 : 319 – 320, 1991.

40. Nichols RL, Smith  JW, Klein DB, et al : Risk of infection after penetrating abdominal trauma. N. Engl. J. Med. 311 : 1065 – 1070, 1984.

41. Nwafo DC: Selective primary suture of the battle – injured colon; an experience of the Nigerian Civil War. Br. J. Surg  67 : 195 – 197, 1980.

42. O'Donnel VA, Lou MA, Alexander JL, et al. Role of antibiotics in penetrating abdominal trauma. Am. Surg. 44 : 574 – 577, 1978.

43. Okies JE, Bricher DL, Jordan GL, et al. Exteriorized primary repair of colon injuries. Am. J. Surg. 124:807 – 810, 1972.

44. Owen-Smith MS: High velocity bullet wounds. Postgraduate Doctor-Africa. 3: 104 – 111, 1981.

45. Owen-Smith MS. Management of high velocity missile wounds. Postgraduate Doctor - Africa. 3 : 303 – 310, 1981.

46. Parks SE, Hastings PR. Complications of colostomy closure. Am. J. Surg. 149 : 672 – 675, 1985.

47. Parks TG; Surgical management of injuries of the large intestine. Br. J. Surg. 68 : 725 – 728, 1981.

48. Parks TG. Gunshot and bomb blast injuries of the large intestine. Br. J. Clin. Pract. 13(1): 7 – 10, 1986.

49. Rintoul RF (ed). Operations on the intestines. In Farquharson's text-book of operative surgery, 6th ed. Churchill Livingstone 1978. Chapter 22, pp 629.

50. Robbs JV, Hagarty MM. The management of colon injuries. S. Afr. Med. J. 49 : 1967 – 1972, 1975.

51. Robbs JV. The alternative to colostomy for the injured colon. S. Afr. Med. J. 53 : 95 – 97, 1978.

52. Schrock TR, Christensen N, Management of perforating injuries of the colon. Surg. Gynecol. Obstet. 135 : 65 – 68, 1972.

53. Schrock TR; Large intestine, In Way LW, (ed). Current surgical diagnosis and treatment, 8th ed. A lange medical book. ch. 32 : 586 – 591, 1988.

54. Shannon FL, Moore EE. Primary repair of the colon: When is it a safe alternative? Surg. 98(4) : 851 – 857, 1985.

55. Shires GT, Thal ER, Jones RC, et al. Trauma. In Schwartz SI, shires GT, Spencer FC(eds). Principles of surgery, 5th ed. Mc. Graw-Hill book Company. Ch. 6: 217 – 284, 1989.

56. Simon GL, Gorbach SL; Intestinal flora in health and disease. Gastroenterology 86 : 174 – 193, 1984.

57. Stone HH, Fabian TC; Management of perforating colon trauma: Randomization between primary closure and exteriorization. Ann Surg. 190(4) : 430 – 435, 1979.

58. Thal ER, Yeary EC. Morbidity of colostomy closure following colon trauma. In Schwartz SI, and others (eds). The year book of surgery 1981. Ch. 4. Trauma, pp 81 – 107, Year book medical publishers inc.

59. Thompson JS, Moore, EE, Moore JB. Comparison of penetrating injuries of the right and left colon. Ann. Surg. 193(4): 414 – 418, 1981.

60. Vannix RS, Carter R, Hinshaw DB, et al. Surgical management of colon trauma in civilian practice. Am. J. Surg. 106 : 364 – 369, 1963.

61. Walt AJ. Management of injuries of the colon and Rectum. Advances in surgery. 16 : 277 – 297, 1983.

62. Yajko RD, Norton LW, Bloemendal L, et al. Morbidity of colostomy closure. Am. J. Surg. 132 : 304 – 306, 1976.

63. Yaw PB, Smith RN, Glover JL. Eight years experience with civilian injuries of the colon. Surg. Gynecol. Obstet. 145 : 203 – 205, 1977.

# APPENDIX I

PROFORMA SHEET

Name _____ Unit number _____ Age _____ Sex _____

Date of admission _____ Date of discharge _____

Bed occupation after initial surgery _____ (days)

Mechanism of injury:

        1.    Stab wound _____

        2.    Gunshot wound _____

        3.    Other (specify) _____

Clinical state at admission:

Pulse rate _____ Resp _____ Temp _____ BP _____ (mm Hg)

Pallor     A.  Present _____    B.  Absent _____

Abdominal examination:

Guarding and/or Rebound tenderness    1.  Yes _____ 2. No _____

Bowel sounds  1.  Present _____    2.  Absent _____

Management:

Perioperative antibiotic administration _____

Interval between trauma and surgery _____ (hrs).

Units of blood used _____

Operative findings:

1.    Number and site of colon injury _____

2.    Number and Location of associated injuries _____

3.    Peritoneal faecal contamination.  A.  Present _____  B.  Absent _____

Type of operative treatment:

A.    Primary repair alone _____

B.    Resection of a segment of bowel and anastomosis _____

C.    Primary closure and proximal colostomy _____

D.    Exteriorization of the lesion as a colostomy _____

E.    Other (specify) _____

Use of peritoneal drain:

Yes _____    No. _____

Morbidity:

1.    Wound sepsis _____

2.    Wound dehiscence _____

3.    Anastomotic breakdown/leakage _____

4.    Intra-abdominal abscess _____

5.    Death if any (specify time) _____

6.    Other (specify) _____

Colostomy closure:

(i)    Post-operative length of stay in the hospital _____ (days).

(ii)    Interval between colostomy formation and closure _____ (weeks).

(iii)    Infectious complications _____

(iv)    Anastomotic disruption _____

(v)    Colostomy problems (specify) _____

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