LAPAROSCOPY AND LOOP COLOSTOMY:

A NEW APPROACH TO EXTRA-PERITONEAL RECTAL INJURIES

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Dissertation presented for the MMed (Surgery) degree

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To my family and colleagues

Your zeal for life and deep concern for the well being of

others motivate my every endeavour

The contents of this dissertation has been in part presented at two clinical meetings:

1. ***The Surgical Research Society Meeting, Breakwater Lodge, Waterfront, Cape Town, July 2000***

2. ***The ASSA-SAGES 2000 22nd Biennial Congress incorporating the Trauma Society of South Africa, the South African Society of Endoscopic Surgeons and the Vascular Society of Southern Africa, Port Elizabeth, November 2000***

The contents of this dissertation has been in part published in abstract form from the above conference proceedings, respectively:

1. **Navsaria PH, Graham R, Nicol AJ.** *A new approach to extra-peritoneal rectal injuries: laparoscopy and trephine loop colostomy.* **Sou Afr J Surg, Nov 2001, Supplement, Vol 38 No. 4, p11**

2. **Navsaria PH, Graham R, Nicol AJ.** *A new approach to extra-peritoneal rectal injuries: laparoscopy and trephine loop colostomy.* **Sou Afr J Surg, Aug 2001, Vol 39 No.3, p99**

The contents of this dissertation has been in part published as an *original article*:

1. **Navsaria PH, Graham R, Nicol AJ.** *A new approach to extra-peritoneal rectal injuries: Laparoscopy and diverting sigmoid loop colostomy.* **J Trauma. 2001; 51: 532-535**

CONTENTS

CHAPTER ONE

BACKGROUND

Introduction

Rectal injuries are associated with significant morbidity and mortality. At the turn of the twentieth century the mortality from rectal wounds approached 90 %[1]. During World War 1 (WW1) rectal injuries were primarily repaired and the mortality dropped to 60 %[1,2]. Routine proximal faecal diversion and presacral drainage became mandatory during the Second World War (WW2) and the mortality decreased to 30 %[1,3]. Irrigation of the distal rectal stump was introduced during the Vietnam and Korean conflicts and the mortality dropped even further to 15 %[4]. From these military experiences four treatment principles have evolved and have been applied to the management of civilian rectal injuries (*Table 1*).

Table 1. The Evolution of Treatment Principles for Rectal Injuries

Period	Treatment	Mortality (%)
1. Early 1900's	Nil	90
2. World War 1	Debridement and repair of rectal wound	60
3. World War 11	i. Proximal diversion of faecal stream ii. Presacral drainage	30
4. Vietnam and Korean Wars	Distal rectal washout	15

The role of prophylactic antibiotics has had a major impact in reducing septic complications and improving outcomes in patients with penetrating abdominal trauma. Fullen et al.[5] in 1972 were the first to describe the role of antibiotics in patients sustaining penetrating abdominal trauma. They retrospectively reviewed patients who underwent laparotomy after sustaining penetrating abdominal wounds and categorised them according to the timing of the first antibiotic dose: *preoperative, intraoperative, and postoperative.* The reported rate of trauma-related infections (incision and intra-abdominal abscess) were 7%, 33%, and 30%, respectively. Individuals with colon injuries had postoperative infection rates of 11%, 57%,and 70% for each group, respectively. Thadepalli et al.[6] demonstrated the importance of broad-spectrum antibiotic coverage for these patients in 1973. This study was a prospective, randomly assigned comparison of kanamycin and cephalothin to kanamycin and clindamycin. Both antibiotic combinations were administered preoperatively. The clindamycin group had a significantly lower rate of infection in the postoperative period compared with the cephalothin group (10% vs. 27%). They further demonstrated that the difference was caused by significantly more anaerobic infections in the cephalothin group. These two studies demonstrated a significantly lower rate of infection when antibiotics providing aerobic and anaerobic coverage were administered before operative treatment. These two reports set the standard for the use of antibiotic prophylaxis in patients with penetrating abdominal injuries.

At present, there is no universal consensus on the application of these surgical principles learnt from the military experiences in the management of civilian rectal injuries, of which distal rectal washout (DRW) and presacral drainage (PSD) have evoked the most controversy.

The past 40 years has seen major advances in civilian pre-hospital care. In addition, trauma

surgeons in specialised Trauma Units now treat many civilian rectal injuries. Surgical Intensive Care Units have been established, and we have a better understanding of the systemic inflammatory response syndrome (SIRS), septic shock and the multi-organ dysfunction syndrome. Interventional radiologists are capable of draining intra-abdominal septic collections percutaneously. The value and routine use of prophylactic antibiotics in penetrating abdominal trauma is well established. Blood products, though a limited resource, remain a vital and an integral part of contemporary trauma care. With all these advances, one can afford to review and re-appraise the application of principles and policies developed for treating rectal injuries under military conditions some decades ago.

Incidence of rectal injury

Blunt and penetrating trauma to the rectum occurs infrequently. They are uncommon in civilian trauma settings. The majority of published series report on a small number of patients collected over long periods of time. In many of the earlier series, no differentiation was made between extra-peritoneal and intra-peritoneal rectal injuries, with both injuries being treated in more or less the same manner. The incidence of isolated extra-peritoneal rectal injuries was unknown and was not quoted in most series of rectal injuries.

Approximately 20 % of patients with penetrating abdominal trauma will have a colonic injury. The incidence is much less for rectal injuries. Colo-rectal trauma occurs in about 2 - 5 % of patients with blunt trauma[7]. The majority of rectal injuries, as reported from urban trauma centers, occur secondary to firearm injuries (80%). Stab wounds and impalements are rare and account for less than 3% of injuries. Blunt trauma accounts for about 10% of rectal injuries. Trans-anal injuries account for approximately 6% of rectal injuries. Aetiologies in this category include auto-erotic accidents, anal intercourse, anal

rape, and iatrogenic or self-induced injuries associated with thermometer insertion, enemas and endoscopic procedures[8].

Mechanism of Injury

The fundamental difference between military and civilian rectal injuries is the mechanism of trauma. High velocity rifles with missile speeds of greater than 914 m/s cause most wartime injuries. In contrast, most civilian rectal injuries are caused by low velocity handguns with missile speeds of less than 305 m/s. The extent and degree of damage in gunshot wounds is proportional to the amount of kinetic energy of the missile dissipated in the wound, which in turn is proportional to the mass of the missile times the square of the velocity. Tissue damage is proportional to the difference between the kinetic energy on impact and exit (*Fig. 1*). Low velocity gunshot wounds tend to exhibit entrance and exit wounds which are smaller than the diameter of the bullet, and a tract of tissue damage not much greater in diameter. A bullet or its fragments may impart sufficient kinetic energy to dense tissue such as bone, teeth, and occasionally metal from clothing that secondary missiles are created. These can not only become highly destructive, but they may also take erratic, unpredictable, and unexpected courses. At high velocities, bullets tend to yaw or tumble in tissue (i.e. their projected transverse areas perpendicular to the missile track), tending to increase the rate of dissipation of kinetic energy, and thus increasing the probability of fragmentation of the primary missile and the formation of secondary missiles. The degree of cavitation, an established and proven principle of wound ballistics, varies with the velocity of the missile, and is greatest in high velocity wounds. Low-velocity missiles tend to push tissue aside, producing a path of destruction only slightly greater than the diameter of the missile. A temporary cavity, is thus created as the missile penetrates the tissues. The size of the cavity

depends on the amount of energy distributed from the moving body to the tissues. The damaged tissue compresses and stretches adjacent tissue out of its normal position. An area of decreased pressure is created in the cavity and the stretched tissue rebounds because of tissue recoil and the sub-atmospheric pressure that is created. The permanent cavity is then much smaller than the temporary cavity. High-velocity wounds display large a cavitational effect with surrounding destruction and large exit wounds when present.

Fig. 1 The principle of dissipation of kinetic energy of ballistics expressed mathematically

[tissue damage ≅ kinetic energy dissipation]

[or]

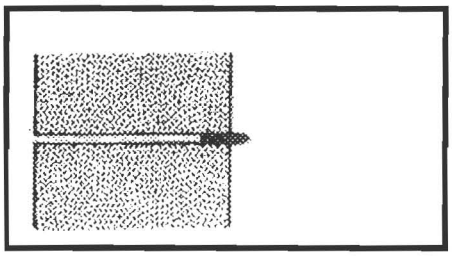
$$[\triangle KE = \tfrac{1}{2} M (V_{entrance}^2 - V_{exit}^2)$$

where *M* equals the mass of the missile and *V* equals its velocity

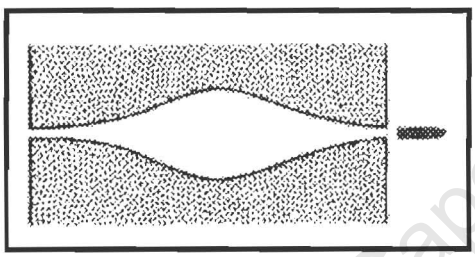
Low-velocity gunshot injuries tend to cause less tissue destruction and smaller cavitational effect, with resultant less surrounding damage and potential for septic complications (*Fig. 2*)[9]

Fig. 2 The ballistic effects of various bullets on simulated human tissue

2.1 Low-velocity missile-small exit and entrance wound with small tract of damage

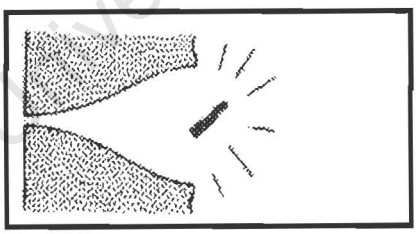


2.2 High-velocity missile showing similar entrance and exit with cavitation.

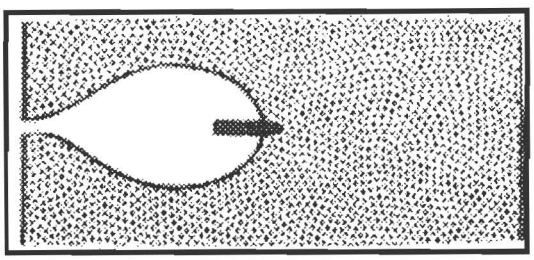


2.3 High- velocity missile showing similar entrance and:-

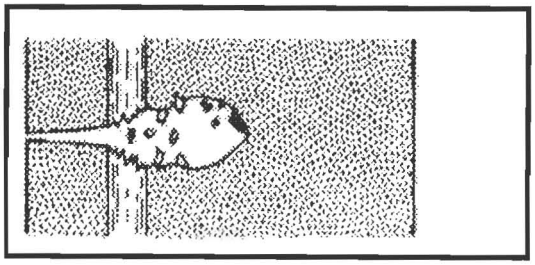
a) enormous exit several times the diameter of the bullet



b) no exit



c) secondary missiles and surrounding damage



Diagnosis of Rectal Injury

The diagnosis of most rectal injuries is not difficult, provided that one has a high index of suspicion. The presence of a transpelvic, perineal, gluteal or upper thigh gunshot wound, or a pelvic fracture, particularly if there are inferior pubic rami or ischial injuries which are displaced, or vaginal bleeding, should arouse the possibility of an underlying rectal injury. Stab wounds or impalements of the buttocks, perineum or lower abdomen should also be suspect. Any patient with a history of anal manipulation, regardless of aetiology, who complains of lower abdominal pain should be evaluated for a rectal injury.

All patients suspected of having a rectal injury should undergo digital examination of the rectum. While this examination may not be sensitive or specific, the presence of blood should trigger the need for further evaluation. Occasionally, a defect may also be palpable on rectal examination. A normal examination does not preclude a rectal injury. If a rectal injury is suspected, a rigid proctosigmoidoscopic examination should be performed. The diagnostic accuracy of digital rectal examination, as quoted in 3 series, was 69, 73 and 96 %, and that of rigid sigmoidoscopy 89, 94 and 96 % respectively[10-12] .

Anatomy of the Rectum

The anatomic location of the rectal injury also has major influence on the management[13]. The rectum, which is about 12 cm long, is continuous with the sigmoid colon at the recto-sigmoid junction at the level of the third sacral vertebra and follows the posterior concavity of the sacrum. The rectum has no mesentery. The visceral pelvic fascia, referred to as the mesorectum, surrounds the rectum. The peritoneum covers the upper third of the rectum at the front and sides and the middle third only at the front. The lower third is below the level of the peritoneum which is reflected on the upper part of the bladder (in the male) or upper vagina to form the rectovesical or recto-uterine pouch respectively. Injuries are thus classified as extra-peritoneal when they occur in those parts of the rectum that are devoid of peritoneal covering. Thus injuries to the entire posterior wall, and to the lower one-third circumferentially, are treated as extra-peritoneal (*Fig. 3*).

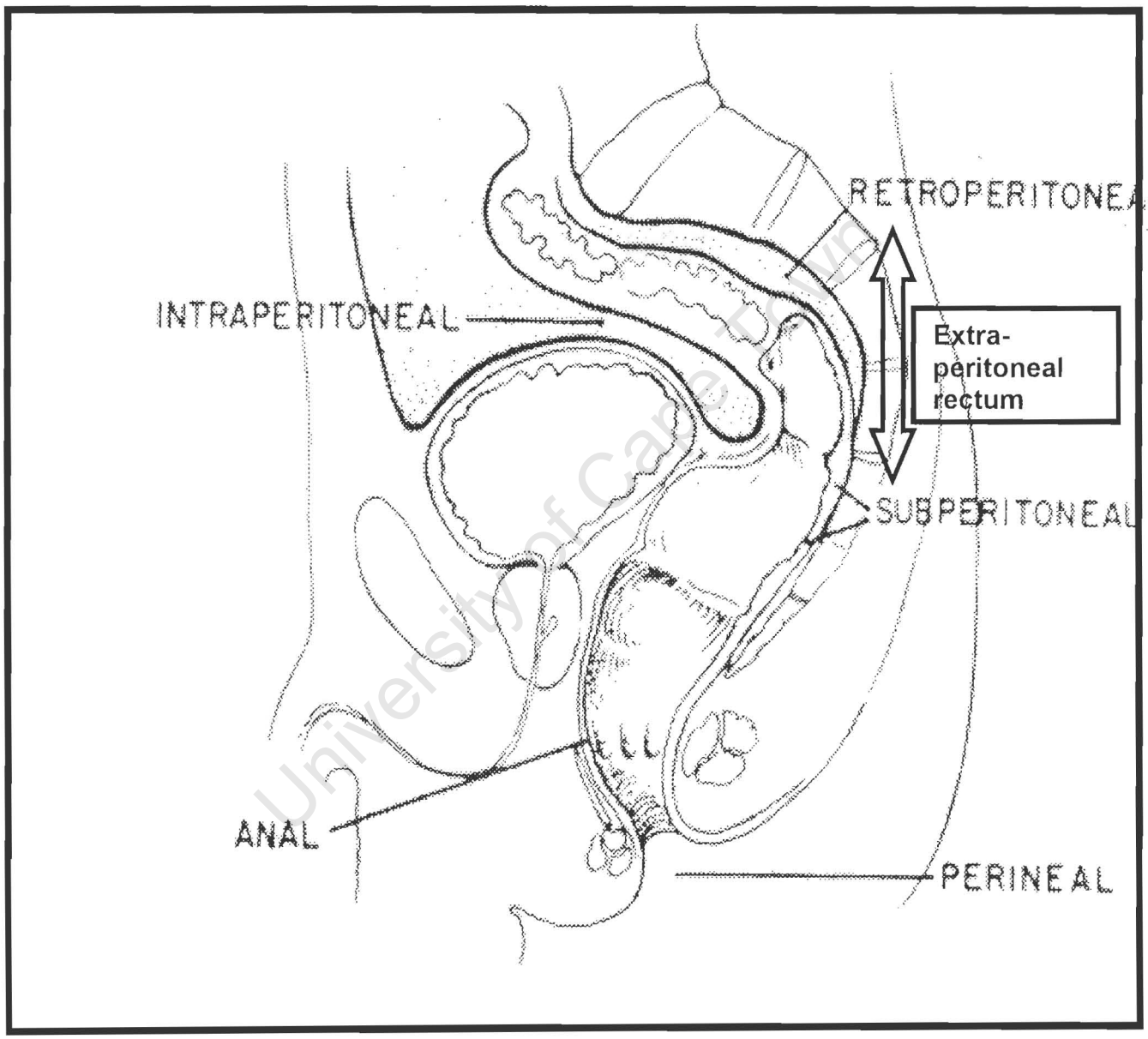
Colostomy and Faecal Diversion

Faecal diversion with colostomy is generally accepted as the standard treatment for both intra- peritoneal and extra-peritoneal rectal injuries. The type of colostomy employed with a view to complete faecal diversion has been a point of some controversy. Four different types of colostomies have been advocated for the treatment of rectal injuries. These include loop colostomy, loop with the distal limb closed, end-colostomy and mucus fistula, and a Hartmann's - type procedure. Regardless of the type of colostomy fashioned, there is universal agreement that it must completely divert the faecal stream.

Initially, loop colostomies were used to prevent faecal contamination of the distal rectal wound. After the World War 11 experience with colostomy and rectal injuries, some

surgeons encountered faecal spillage into the distal limb and switched to divided colostomies[14-16].

Fig. 3 Anatomy of the rectum showing intra- and extra-peritoneal portions



Rombeau and colleagues[17] have shown that a properly performed temporary skin level transverse loop colostomy completely diverts the faecal stream. Further studies have confirmed the efficacy of total diversion of loop colostomies, including one by Morris et al.[18]

on temporary loop stomas fashioned for trauma. Despite this evidence, there are many surgeons who do no accept that a loop stoma can achieve complete diversion[14-16]. Some recommend its use, but with closure of the distal limb[19]. This is achieved by either using a linear stapler across the distal limb, suturing the distal limb closed with a non-absorbable purse-string suture, or ligating the distal limb closed with a non-absorbable suture[19]. A loop colostomy has the added advantage of the rapidity of construction and its ease of closure by avoiding a laparotomy.

The trephine stoma, introduced in the early 1990's, has been praised as an improved means of faecal diversion. It involves the formation of a stoma without laparotomy. The stoma is created through an abdominal wall trephine of about 3 - 4 cm in diameter. Anderson et al.[20] showed have shown that the operating time and opiate requirements were less in patients in whom stomas were fashioned via an abdominal trephine than for patients who underwent laparotomy for stoma formation. Most centers, including our Trauma Unit now employ the loop colostomy in the management of rectal injuries.

Distal Rectal Washout (DRW)

DRW was employed during the Vietnam and Korean conflicts, where most reports showed significant reduction in pelvic sepsis and improved mortality. Lavenson and Cohen[4] in 1971 published their experience with DRW in the Vietnam conflict and showed that since its application, their morbidity was reduced from 72 % to 10 % and the mortality dropped from 22 % to zero.

Experimental confirmation of bacterial translocation across gut mucosa implied that faeces retained in the defunctioned colon may potentiate or produce septic complications. DRW became more popular because it was thought to reduce gut bacterial translocation and hence

septic complications. Shannon et al.[16] in a retrospective study of a small group of 26 patients reported septic pelvic complications in six of 13 patients (46%) without irrigation and only one of 13 (8%) with irrigation. Interestingly, the benefit was the greatest for high- energy trauma due to high-velocity gunshot wounds and pelvic fractures. Several reports on civilian trauma also advocate distal rectal irrigation, although the data do not support that conclusion[19,21,31-35]. The value of DRW in the management of civilian rectal wounds has therefore been questioned. Present day experience with civilian rectal trauma with low velocity gunshot wounds tends to show no benefit from DRW. Burch and Feliciano[19], in a retrospective review of 128 patients, of whom 50 % had DRW, showed no benefit or harm from DRW. Similarly, Huber and Tuggle[21] in their retrospective study of 47 patients, performed DRW in only one patient and experienced no increase in sepsis. While it is not clear that irrigation is beneficial, it is at least not harmful. This is an important consideration, because irrigation may theoretically force faecal material through unsutured extra-peritoneal perforations and increase the risk of pelvic sepsis. The failure of the civilian trauma literature to demonstrate the benefits of irrigation may be related to the small volume of stool in the rectum of civilians compared to soldiers, who may not have the opportunity for regular bowel movements and are often constipated[8]. There is, thus, no conclusive evidence that irrigation of the distal rectal lumen is an essential adjunct to the management of civilian rectal injuries caused by low-velocity weapons.

Presacral Drainage (PSD)

Presacral drainage was popularised during the Second World War. It entails placement of a drain/s in the pre-sacral area. The placement of the drain can take place during laparotomy with the drain exiting through the abdominal wall. Alternatively, with the patient in the lithotomy position, the drain can be placed through a separate curvilinear incision, made in

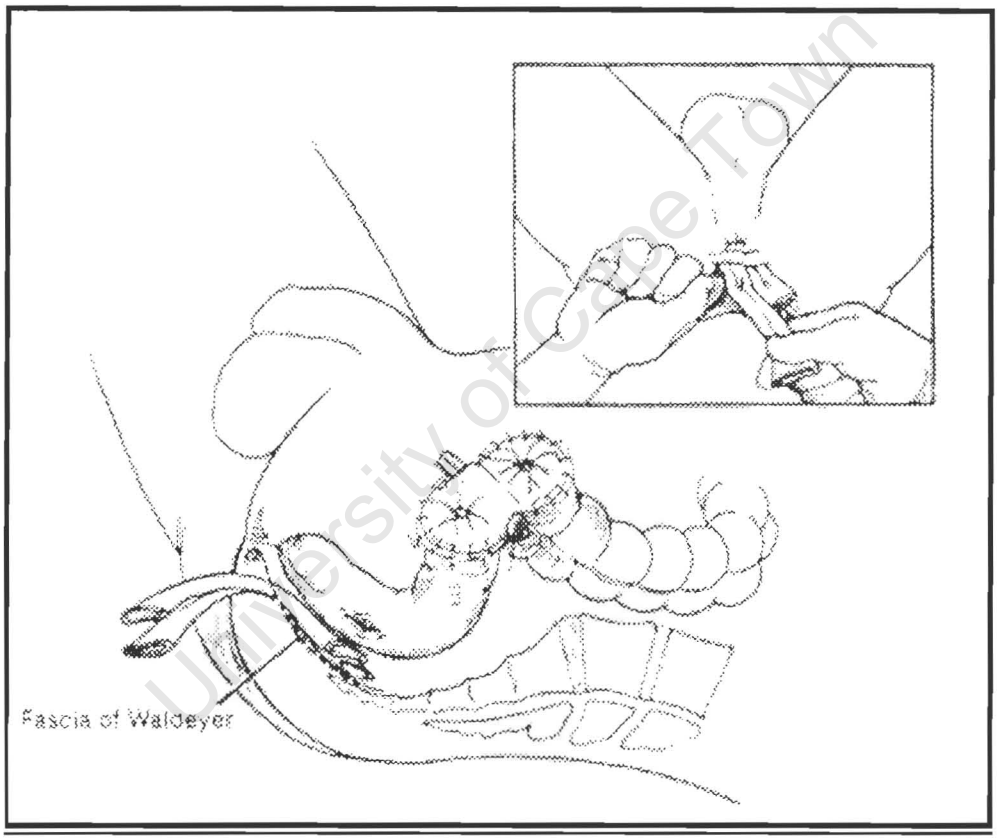
the anococcygeal raphe (*Fig. 4*). The pre-sacral space is then opened posterior and laterally with blunt dissection and drains placed in these newly opened spaces. Presacral drainage became an important adjunct in the management of rectal injuries since Lavenson and Cohen[4] reported their results in 1971. The reported reduction in the pelvic abscess rate from 36% to 25 % with retro rectal drainage by Armstrong et al.[22], made presacral drainage routine in many centres. However, many series, including those by Thomas et al.[10], Mangiante et al.[11] and Bostic et al.[23], showed no benefit from presacral drainage for extra-peritoneal rectal injuries. Despite their findings, they still recommended its use. In the only randomised study which evaluated PSD in civilian rectal trauma, Gonzales et al.[24] found that PSD without DRW did not reduce infectious complications. The evidence to support PSD for civilian rectal trauma caused by low-velocity gunshot wounds appears to be very weak. There is not much debate when it comes to the value of PSD in patients with high-energy rectal trauma[4,12,15,19,35,36].

Associated Genitourinary Tract Injuries

Genitourinary (GU) tract injuries are among the commonest lesions associated with rectal Trauma[13,21,22]. The bladder alone, has been reported to be injured in approximately 30% of patients with rectal injuries[19,21]. The management of an isolated genitourinary tract injury is site-specific and is associated with little controversy. The results of genitourinary tract and rectal injuries have been studied separately and reported as such. However, there are very few reports on the management of combined genitourinary and rectal trauma. Franko et al.[25], in a subset of 17 patients with combined penetrating rectal and genitourinary tract injuries in a series of over 200 rectal injuries, showed a high complication rate including a recto-vesical / urethral fistula rate of 24 %. They implicated the failure to perform PSD or DRW, rectal wound repair, prolonged suprapubic drainage and failure to separate the

rectal and GU tract wounds as the major factors in the pathogenesis of such complications. The management of combined GU and rectal injuries remains unresolved. Due to the risk of rectovesical fistula and ongoing sepsis, the current recommendation and practise is to close both perforations and separate the suture lines with viable omentum interposed between them.

Fig 4. Placement of presacral drain via the transperineal route

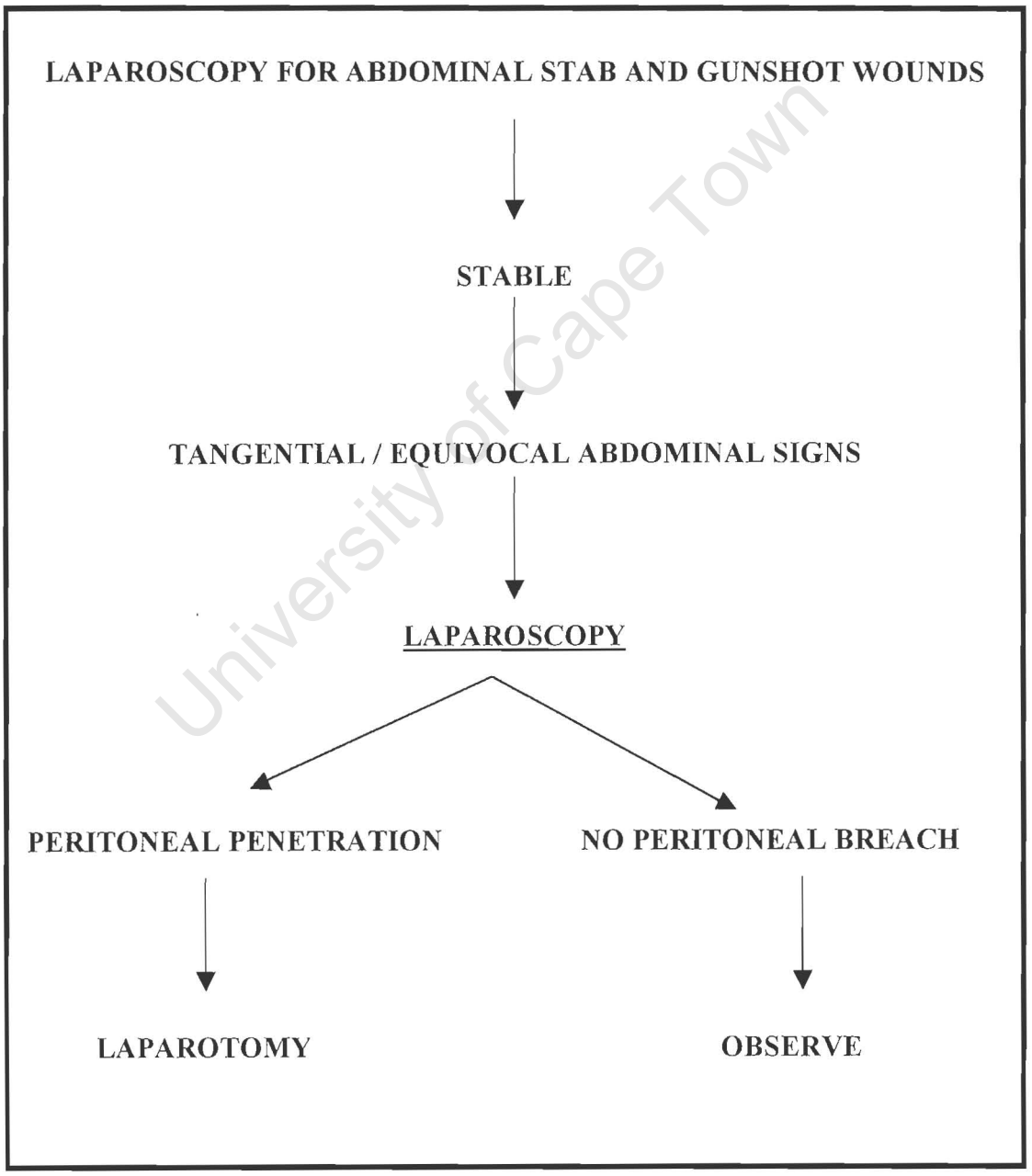


DIAGNOSTIC LAPAROSCOPY FOR PENETRATING ABDOMINAL TRAUMA

The reduction of negative and non-therapeutic laparotomies is one of the major goals in the management of the trauma patient. The major role of laparoscopy in penetrating abdominal trauma is that it avoids unnecessary laparotomy in non-penetrating, tangential stab and

gunshot wounds. The following algorithm has been set forth for the management of patients with abdominal stab or gunshot wounds who are haemodynamically stable, have no signs of peritonitis, or have equivocal abdominal signs (*Fig. 5*)[26]. The patients with normal laparoscopic examinations can be spared a laparotomy. The major disadvantage of

Fig. 5 Algorithm for Laparoscopy in Penetrating Trauma to the Abdomen



laparoscopy appears to be the poor detection of hollow viscus injuries[27]. The procedure also requires general anaesthesia and is performed in the operating room. Also, laparoscopy has a significant learning curve and requires a surgeon with expertise to be present during the procedure.

According to current ATLS (Advanced Trauma and Life Support®)[28] guidelines, the detection of blood on digital rectal examination following penetrating trauma, is an indication for exploratory laparotomy. However, an isolated extra-peritoneal rectal injury with no intra-peritoneal violation and associated visceral injury, will have minimal or even no peritoneal signs, since the injury is below the peritoneal reflection and anatomically outside the peritoneal cavity. In the presence of an isolated extra-peritoneal rectal injury and a normal diagnostic laparoscopy, a sigmoid loop stoma for the diversion of the faecal stream can easily be raised and fashioned through an abdominal wall trephine without a laparotomy being performed.

Current Trends in the Management of Rectal Injuries

Because the treatment of civilian rectal injuries usually follows the most recent military trend, colostomy and drainage and, to a lesser extent rectal irrigation has been embraced by civilian trauma surgeons as the foundation for the treatment of rectal injuries. However, because civilian rectal injuries are uncommon, there remains considerable differences regarding the optimal type of colostomy, the method of drainage, the role of irrigation, and the necessity for repair of the rectal wound. Thus, no ideal management protocol for the treatment of civilian extra-peritoneal rectal injuries exists. The current treatment involves a combination of techniques learned from military experiences, where the majority of the injuries are the result of high-velocity gunshot wounds. The treatment of choice for the

majority of civilian gunshot intra-peritoneal colon injuries is primary repair[29-35]. Primary repair of extra-peritoneal rectal perforations is still a controversial issue. This form of treatment was enthusiastically recommended during the Vietnam conflict. However many authors feel this is not a priority in civilian injuries[29-35]. Unfortunately primary repair is not always technically feasible, and also there is no evidence to support the primary repair of extra-peritoneal rectal injuries. That two-thirds of the rectum is extra-peritoneal, that it is difficult to mobilise the rectum into the peritoneal cavity, and that much of the rectum is surrounded by the rigid bony pelvis, needs to be considered when treating patients with rectal injuries. Because of these anatomical factors and the technically difficult dissection, wounds of the extra-peritoneal rectum cannot be reliably treated by primary repair, and the surgeon must rely on resection or proximal diversion, with or without drainage.

Ivatury et al.[34] closed only 37% of cases with no increase in sepsis. Tuggle and Huber[21] were unable to demonstrate an advantage to repair, and Mangiante et al.[11] stated that many of the injuries in their series were not amenable to repair. Burch et al.[19] repaired only 21%, and these only by virtue of mobilising other structures , such as bladder and vagina that required repair.

In the last two decades, only two papers, solely addressing the subject of extra-peritoneal rectal injuries, have appeared in the English literature. Velmahos et al.[35] retrospectively reviewed 30 patients with civilian extra-peritoneal gunshot wounds. The management techniques employed, associated bladder injury and outcomes of these patients are shown in Table 2. There were two complications directly associated with the rectal injury: one patient in group A developed a rectovesical fistula and one in group B developed a rectocutaneous fistula. They concluded that diverting colostomy without rectal repair or drainage appears to

be safe for the management of most civilian extra-peritoneal rectal gunshot wounds. Additional surgical manoeuvres may be required for combined rectal and urinary tract trauma or other complex rectal injuries.

Levy and colleagues[12] reported their experience with 26 extra-peritoneal rectal gunshot injuries. A summary of the various modalities used to treat these 26 patients is shown in Table 3. Their results did not support the need for PSD and DRW. Repair of the rectal wound was performed only when easily accessible, when encountered during dissection to repair other injuries, and with associated genitourinary injuries.

The current recommendations for the surgical management of rectal injuries is that all intra-peritoneal injuries are repaired primarily with or without proximal faecal diversion. Extra-peritoneal rectal injuries are repaired if: (1) they are readily accessible with minimal dissection, (2) the rectal wound is exposed during dissection to repair associated injuries, such as exposing the iliac vessels or vagina, or (3) possibly in patients with associated genitourinary injuries. Extra-peritoneal rectal injuries are otherwise left untouched and the faecal stream diverted proximally with a colostomy, and a transperineal or transperitoneal presacral drainage procedure performed, although the benefit of a drainage procedure in the civilian trauma setting has been questioned.

Table 4 summarises the outcome of the management of recently published series of civilian intra- and extra-peritoneal rectal injuries. Only two series, as mentioned above, solely address the management of extra-peritoneal rectal injuries.

To our knowledge, there is no other other center treating isolated extra-peritoneal rectal injuries by performing a diagnostic laparoscopy to exclude associated intra-peritoneal injuries, and fashioning the defunctioning loop colostomy through an abdominal wall

Table 2. Summary of the surgical management and complications in 30 patients with extra-peritoneal rectal injuries (Velmahos et al.)[35]

	Simple colostomy (A)	Primary repair and colostomy (B)	Presacral drainage and colostomy (C)
No. of patients	*12*	*12*	*6*
Associated bladder injury	*2*	*5*	*3*
Complication related to rectal injury	*Vesicorectal fistula*	*Rectocutaneous fistula*	*nil*

Table 3. Summary of the surgical management of 26 extra-peritoneal rectal injuries (Levy et al.)[12]

	Rectal repair	Rectal wound left open
Loop colostomy (n=10)	*3*	*7*
Loop colostomy + DRW (n=2)	*0*	*2*
Loop colostomy + PSD + DRW (n=2)	*0*	*2*
Hartmann + PSD + DRW (n=12)	*7*	*5*

trephine, thus sparing the patient a major laparotomy wound. We believe that the application of DRW and PSD should be based on the mechanism of the trauma. Patients with high-energy trauma to the rectum have been shown to benefit from DRW and PSD, whereas patients with low-energy trauma to the rectum, probably do not.

Table 4. Results of the treatment of rectal injuries in recent published series

Author, Year	Period of Study (years)	No. of patients	Mortality (%)	Morbidity (%)	
				Abscess	Fistula
MILITARY					
Lavenson[4], 1971	1	29	4 (14%)	14(48%)	6(20%)
Armstrong[36], 1973	2	32	4(13%)	15(47%)	1(3%)
CIVILIAN					
Wanebo[37], 1969	22	15	4(27%)	-	-
Trunkey[38], 1973	10	5	5(11%)	2(4%)	0
Robertson[39], 1982	24	36	0	3(8%)	0
Vitale[14], 1983	5	32	2(6%)	2(6%)	0
Grasberger[15], 1983	8	20	2(10%)	5(25%)	1(5%)
Huber[21], 1984	8	47	0	1(2%)	3(6%)
Mangiante[11],1986	15	43	0	4(9%)	0
Shannon[16], 1988	6	27	10(4%)	7(27%)	4(15%)
Burch[19], 1989	10	100	4(4%)	4(4%)	3(3%)
Ivatury[34] 1991	14	54	3(4%)	3(5%)	1(2%)
**Levy[12], 1995*	*19 months*	*26*	*2(4%)*	*6(24%)*	*2(8%)*
McGrath[13], 1998	5	58	1(2%)	8(13%)	0
**Velmahos[35], 2000*	*4*	*30*	*0*	*1(3%)*	*2(6%)*

* These two series report on the management of extra-peritoneal rectal injuries

CHAPTER TWO

RETROSPECTIVE STUDY OF THE MANAGEMENT OF A SELECT GROUP OF PATIENTS WITH ISOLATED EXTRA- PERITONEAL RECTAL INJURIES USING LAPAROSCOPY AND LOOP COLOSTOMY

AIM

Current evidence in the English literature tends to support a more conservative surgical approach to civilian rectal injuries caused by low-velocity missiles. Distal rectal washout and presacral drainage appear to have little or no influence on the morbidity and mortality in patients with low-energy trauma to the rectum. The ever-increasing popularity and obvious advantages of minimal access surgery have prompted surgeons to apply its use to a variety of surgical diseases, including trauma-related conditions.

This study retrospectively reviews and examines the safety and efficacy of laparoscopy and the formation of a diverting sigmoid loop colostomy through an abdominal wall trephine, in a limited number of carefully selected patients with isolated extra-peritoneal rectal injuries. The patient is thus spared a major laparotomy wound. The value of distal rectal washout and presacral drainage in such injuries is also examined.

PATIENTS AND METHODS

The records of all patients with rectal injuries admitted to the Trauma Unit at Groote Schuur Hospital from January 01, 1995 to September 30, 2000 were reviewed. The patients' Revised Trauma Score was calculated and recorded on admission. All patients were resuscitated along ATLS® guidelines. Those patients with an acute abdomen and a suspected rectal injury on admission, were taken to the operating theatre and subjected to an examination under anaesthesia and exploratory laparotomy. The intra-abdominal injuries

encountered at laparotomy were managed as necessary. All intra-peritoneal rectal injuries were repaired and all extra-peritoneal rectal injuries were left alone, unless encountered during dissection to manage other injuries. All rectal injuries were managed by performing a trephine loop colostomy, proximal to the injury. These patients were excluded from the study.

Patients presenting with haematuria were investigated with an intravenous pyelogram and cystogram. Patients with positive radiological findings were treated via laparotomy if necessary and were also excluded from the study.

Those patients with a suspected or confirmed rectal injury, and either no evidence of an acute abdomen or equivocal abdominal signs, with no genitourinary tract injury, were subject to laparoscopy under general anaesthesia. If the laparoscopic examination was normal, a defunctioning sigmoid loop colostomy was fashioned in the left iliac fossa through an abdominal wall trephine, without a laparotomy being performed.

Diagnosis of a Rectal Injury

The diagnosis of a rectal injury was suspected in all patients with transpelvic, gluteal, upper thigh gunshot wounds and pelvic fractures. All patients with a bullet trajectory in the vicinity of the pelvis and pelvic fractures underwent digital rectal examination as part of the initial assessment. If the digital examination was normal in a patient with a high index of suspicion based on the bullet trajectory, the examination was completed with a proctosigmoidoscopic evaluation. The digital rectal examination results were recorded according to whether there was gross blood or a palpable lesion. Sigmoidoscopy results were called positive by visualisation of either the lesion or the presence of gross blood.

Diagnostic Laparoscopy

Diagnostic laparoscopy was performed under general anaesthesia with the patient in the lithotomy position. The lithotomy position facilitates proctosigmoidoscopic examination, DRW and PSD when indicated, and the convenient placement of the monitor screen (*Fig 6*). Laparoscopy was performed using the standard open technique. A 1,5 - 2 cm sub-umbilical vertical incision was made. The abdominal cavity was directly entered with scalpel, electrocautery and scissors. A 10-mm trocar was placed directly into the peritoneal cavity and its position secured with two stay-sutures to the rectus sheath. The peritoneal cavity was then rapidly insufflated with carbon dioxide to achieve a pneumoperitoneum at 15 mm Hg of pressure. A 10 mm camera was then inserted through the trocar and the peritoneal cavity viewed on the monitor. The patient was then tilted head up, head down, to the left and to the right and combinations thereof to achieve thorough visualisation. We have not found it necessary to insert additional trocars to achieve adequate visualisation. In the patients in whom the laparoscopic examination was normal, a diverting loop sigmoid colostomy was fashioned in the left iliac fossa through an abdominal trephine without laparotomy.

Formation of a trephine loop colostomy (Fig. 7)[40]

The abdominal trephine was begun by excising a disc of skin over the stoma site, usually in the left iliac fossa in the rectus muscle. A disc of subcutaneous fat was excised. The anterior rectus sheath was then exposed and a cruciate incision made over it to expose the muscle fibres. The muscle fibres were either split or cut with diathermy. The posterior rectus sheath and peritoneum was then opened with diathermy. The sigmoid colon was then lifted through this trephine, taking care not to twist it and a skin level loop colostomy was fashioned.

Fig. 6 Theatre arrangement for patient undergoing diagnostic laparoscopy for suspected extra-peritoneal rectal injury.

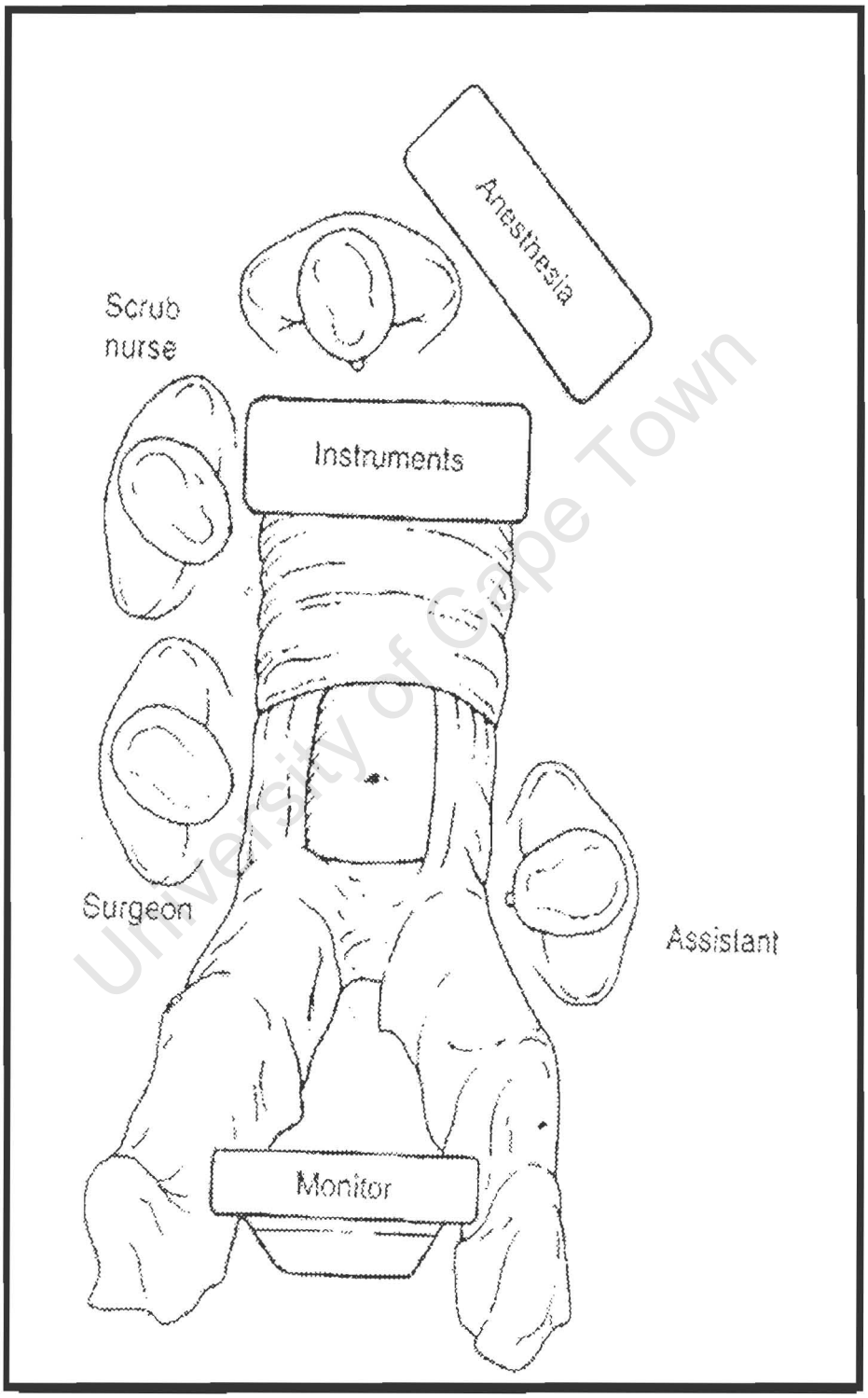
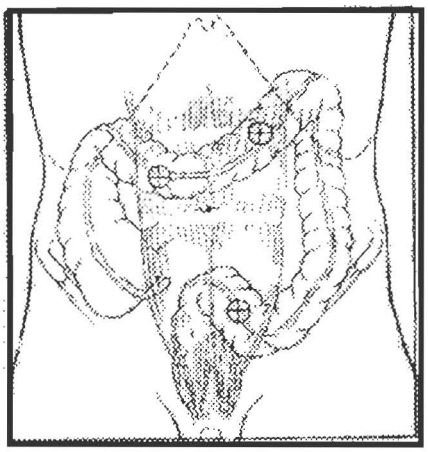
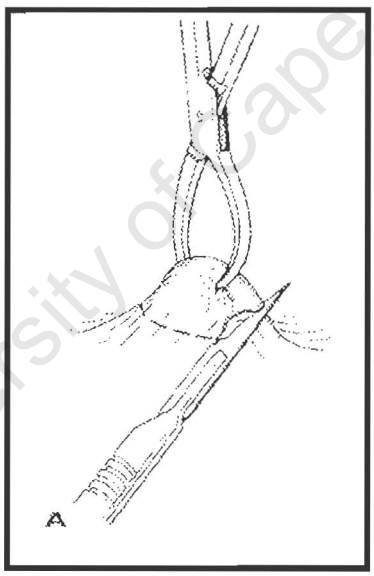


Fig. 7 The formation of a trephine colostomy

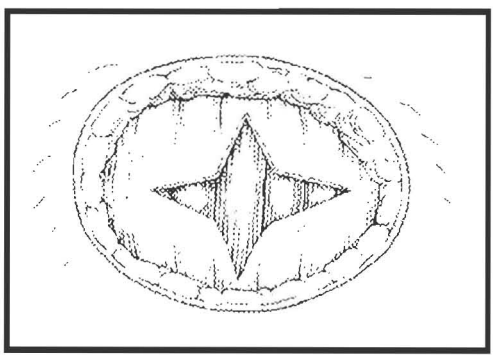
1. The optimum site is marked - left iliac fossa for sigmoid loop stomas



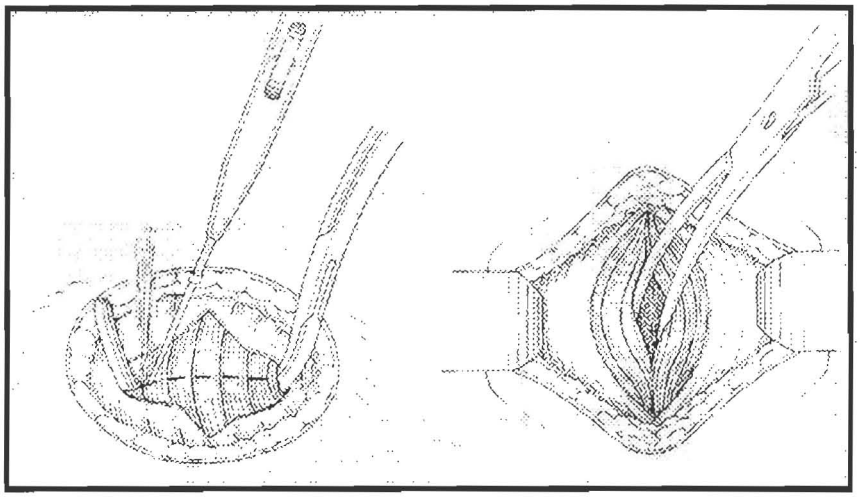
2. A disc of skin and subcutaneous fat is excised



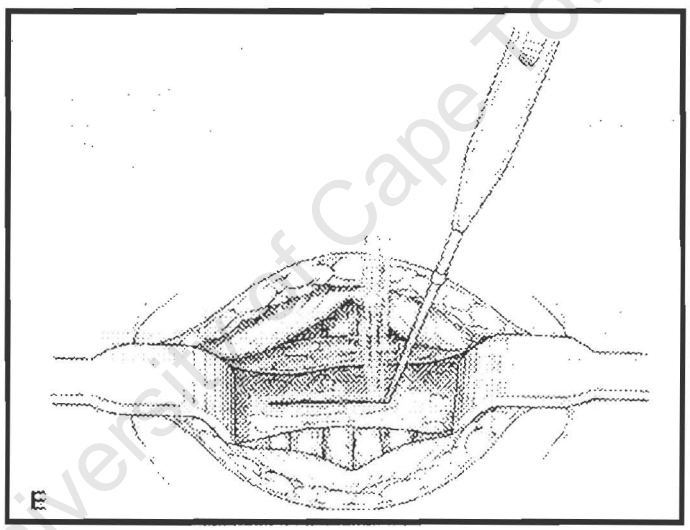
3. A cruciate incision is made in the anterior rectus sheath



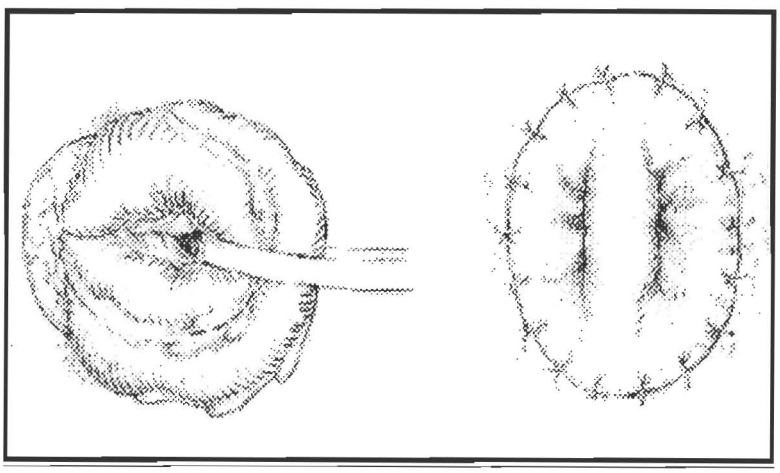
4. *The rectus muscle is elevated and either divided or split*



5. *Langenbeck retractors expose the posterior sheath the peritoneum is opened*



6. *The sigmoid colon is elevated and a skin level loop colostomy fashioned*



Antibiotics

All patients received prophylactic antibiotics. Penicillin, gentamicin and metronidazole were administered in the perioperative period in the following doses: penicillin - 2 mega units stat then six hourly, gentamicin - 6 mg/kg stat then daily and metronidazole in 500 mg doses, stat and then eight hourly thereafter. Antibiotics were administered for a minimum of forty-eight hours and continued till the patient remained afebrile for a period of twenty-four hours.

Presacral drainage and Distal rectal washout

No PSD was performed and DRW was performed at the discretion of the attending surgeon.

Post-operative management

The patients underwent routine post-operative management. Feeding was commenced as soon as air was detected in the stoma bag. Stoma education and care was commenced on the first post-operative day. Patients were discharged as soon as they showed competency with changing the stoma bags and tolerated an oral diet.

Colostomy closure

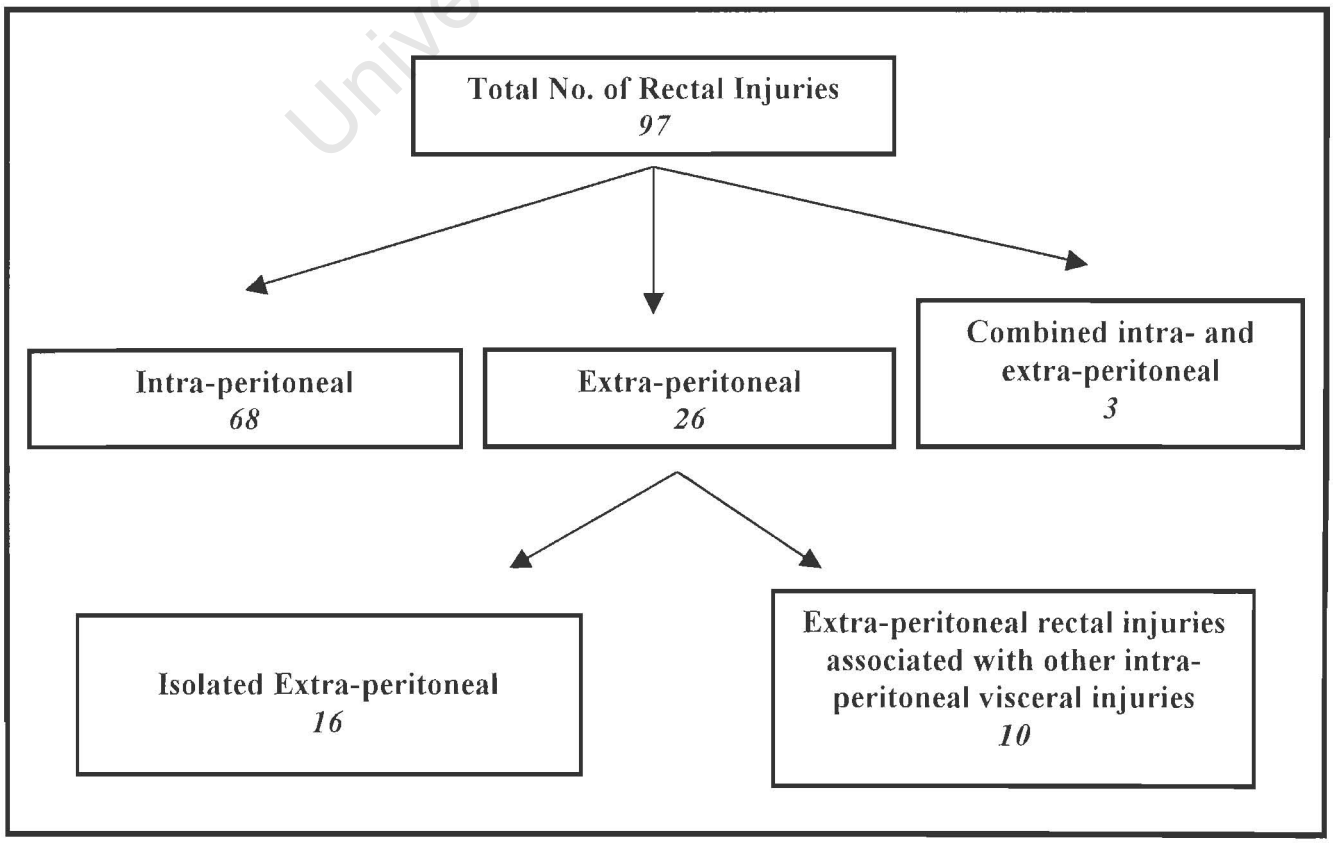
Colostomy closure was planned for three months from discharge. Prior to closure all patients underwent digital examination to evaluate sphincter function. Since none of the extra-peritoneal rectal injuries were adequately visualised, explored or repaired, a barium contrast enema was considered mandatory prior to colostomy closure to document healing of the rectal wound and to rule out any stricture formation,. The potential complication of stricture formation could theoretically occur on the basis of healing of the rectal wound with scarring and/or ischaemia from the injured blood supply to the rectum at initial insult.

CHAPTER THREE

RESULTS

During the period 01 January 1995 to 30 September 2000, 97 patients with rectal injuries were treated in the Trauma Unit. Of these 97 patients with rectal injuries, 68 (70.1%) had injuries to the intra-peritoneal rectum. Twenty-six patients (26.8%) had an injury to the extra-peritoneal parts of the rectum. Three patients (3.1%) had combined intra- and extra-peritoneal rectal injuries. Of the 26 patients with extra-peritoneal rectal injuries, only sixteen had an injury to the extra-peritoneal portion of the rectum without any other associated intra-abdominal injury, as manifest by the absence of overt peritonitis (*Table 5*). Eighty-one patients (*intra-peritoneal 68, combined intra- and extra-peritoneal 3, extra-peritoneal with associated intra-peritoneal visceral injuries 10)* had clinical signs of peritonitis (*tenderness, rebound, guarding, rigidity, diminished or absent bowel sounds*) and proceeded to exploratory laparotomy.

Table 5. Rectal Injuries: January 1995 - September 2000



There were fifteen males and one female. The average age of the group was 27 years (range 17 to 54 years). The mechanism of injury was a low velocity gunshot in fifteen patients and a motor vehicle accident with a stable pelvic fracture in one patient. The mean Revised Trauma Score was 11.9 (*Table 6*).

Table 6. Demographic data of 16 patients

Average age	27 years (range 17 -54)
Gender:	
males	15
females	1
Mechanism of Injury:	
GSW	15
MVA	1
Average Revised Trauma Score	11,9

Associated injuries

Eight of the sixteen patients had additional injuries (*Table 7*). A disruption of the

superficial femoral artery in one patient was repaired with a reverse saphenous vein graft. There were two patients with stable compound pelvic fractures which were managed conservatively. The patient with a compound fracture of the tibia and fibula required washout and external fixation and the patient with a fracture of the femur was managed with an intramedullary nail. The other associated injuries included a compound fracture of the calcaneus in one patient and soft tissue injuries to the scrotum and penis in another.

Table 7. Associated injuries

Superficial femoral artery laceration	1
Compound tibia and fibula fracture	1
Minor head injury	1
Compound femur fracture	1
Compound pelvic fracture	2
Calcaneus fracture	1
Penis and scrotum (soft tissue only)	1

Urological injuries

None of the patients had macroscopic haematuria. Four patients had microscopic haematuria and all four had normal intravenous pyelograms and cystograms. In six patients no record of

the urine microscopy findings could be found. We presume that these were normal and not documented in the folder, as no further investigation of the urinary tract was performed. Six patients had no abnormality on urine dipstick examination (*Table 8*).

Table 8. Urinary findings

Macroscopic haematuria:	0
Microscopic haematuria:	4
IVP and cystography	4 normal studies
Normal urinary findings	6
Undocumented microscopy findings	6 (presumed normal)

Management of the rectal injury

Digital rectal examination was performed on all patients. Fourteen patients had gross blood on the glove. Sigmoidoscopy was performed in fifteen patients. Fourteen patients had gross blood present while one patient's findings were recorded as "inconclusive".

Laparoscopy was performed in fourteen patients and was found to be normal. In the two patients in whom laparoscopy was not performed, the attending surgeons were confident that the rectal injury was extra-peritoneal, based on the fact that the time elapsed from time of injury to time of admission, was long enough to exclude an intra-peritoneal injury by the

absence of clinical signs of peritonitis. DRW was performed in two patients. None of the patients had PSD.

All sixteen patients had a diverting loop sigmoid loop colostomy fashioned in the left iliac fossa (*Table 9*).

Table 9. Injury and management data

Patient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Digital rectal examination																
Gross Blood	+	+	+	-	+	+	+	+	+	+	-	+	+	+	+	+
Laceration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proctosigmoidoscopy																
Gross blood	+	+	+	+	?	-	+	/	-	+	+	+	+	+	+	+
Laceration	-	-	-	-	?	-	+	/	-	-	-	+	-	-	-	-
Inconclusive	/	/	/	/	+	/	/	/	/	/	/	/	/	/	/	/
Surgical Management																
Laparoscopy	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+
Trephine loop colostomy	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
DRW	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
PSD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outcome																
Wound sepsis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other infection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Complication	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Missed injury	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Colostomy closure compl'n	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Days in Hospital																
First admission	5	5	4	4	5	5	5	4	5	4	5	5	4	5	5	5
Subsequent admission	4	4	5	4	4	3	4	4	4	4	9	5	5	4	4	4

Post-operative course and outcome (*Table 10*)

All patients received penicillin, gentamicin and metronidazole for an average of 72 hours. The average hospital stay related to the rectal trauma was 4,7 days. There were no

complications related to the formation of the stoma. Furthermore, there were no general

Table 10. Outcome

Average length of hospital stay related to rectal trauma	4,7 days (range 4 - 5 days)
Morbidity	
General - Sepsis Wound Respiratory tract Urinary tract Drip site	nil
Related to rectal trauma Pelvic sepsis Rectovesical / rectocutaneous fistula	nil
Other Missed urethral injury presenting as a thigh abscess	1
Mortality	nil

complications such as wound, drip site, urinary or respiratory tract sepsis. No complications related to the rectal trauma occurred; in particular no pelvic sepsis or rectovesical or rectocutaneous fistula were observed.

One patient however developed an abscess in the right thigh related to the bullet tract. Following incision and drainage, he developed an obvious urine leak from the depths of the wound. An ascending cyst-urethrogram confirmed a urethrocutaneous fistula which was then treated by prolonged suprapubic drainage and delayed urethroplasty.

Closure of colostomy

All sixteen patients have had their colostomies closed. Colostomies were closed at a mean of three months (range 2-5 months) following the injury. Of the sixteen stomas that have been closed, no abnormalities on the pre-operative barium enemas were detected. Pre-closure digital examination was normal in all patients. One patient developed an anastomotic leak following closure of his colostomy. This was detected early, and the anastomotic leak exteriorised as a loop colostomy. He made an uneventful recovery and intestinal continuity has since been re-established (*Table 11*) .

Table 11. Colostomy Outcome

Pre-closure barium enema	16 normal studies
Average time to closure	3 months (range2-5 months)
No. of stomas closed	16
Complications	1 anastomotic leak

CHAPTER FOUR

DISCUSSION

Rectal injuries are associated with significant morbidity and mortality. The majority of reported urban civilian rectal injuries are caused by of low-velocity gunshot wounds. In addition, there is a high incidence of associated intra-peritoneal visceral injuries which require a laparotomy for their definitive treatment. The current trend in the management of civilian rectal trauma supports a more conservative surgical approach.

Military surgeons introduced distal rectal washout and presacral drainage in the management of wartime rectal injuries[1-4,22]. These injuries were mainly the result of high-velocity missile trauma. They undoubtedly showed that the use of these two adjuncts in the management of wartime rectal trauma significantly reduced the incidence of sepsis and fistulae, and improved survival. However, civilian rectal injuries, which occur predominantly from low-velocity missiles, appear not to benefit from DRW[19,21] and PSD[10,11,24]. There is very little evidence in the current trauma literature to support the use of DRW and PSD in the management of urban, civilian rectal injuries caused by low-velocity trauma.

The repair of extra-peritoneal rectal injuries is also not always technically feasible, and there is little evidence to support the primary repair of extra-peritoneal rectal injuries. Two-thirds of the rectum is extra-peritoneal, and is difficult to mobilise into the peritoneal cavity. In addition, the fact that much of the rectum is surrounded by the rigid bony pelvis, needs to be taken into consideration. Because of these anatomical features and the technical difficulty with the dissection, wounds of the extra-peritoneal rectum cannot be reliably and easily treated by primary repair, and the surgeon must rely on resection or proximal

diversion, with or without drainage.

There is very little controversy regarding the type of stoma employed to defunction the injured distal rectum. Most series report the use of a skin-level diverting loop colostomy. Although these are fashioned via an abdominal wall trephine, a concomitant laparotomy is almost always performed to exclude and manage associated intra-abdominal injuries. The formation of a diverting loop colostomy via an abdominal wall trephine, without a laparotomy has been proven to be an adequate means of faecal diversion[20].

The focus of modern trauma management is on appropriate and timely surgical intervention. Haemodynamically unstable patients are managed with operative intervention. In both stable patients with no urgent indications for laparotomy, and patients with obvious internal organ injuries but without haemodynamic compromise, the current approach is judicious use of investigative techniques to determine the need for operative intervention. Serial physical examination can be supplemented by peritoneal lavage, ultrasonography, and CT scanning. Each has found a niche in trauma management.

Videolaparoscopy is the newest modality to find a role in the evaluation and treatment of abdominal trauma. The general consensus is that laparoscopy has a limited role in the evaluation of blunt trauma. Penetrating trauma seems to offer more opportunities for laparoscopy. Laparoscopy has been noted to be extremely useful to determine peritoneal penetration from stabbing and gunshot wounds. In selected stable patients without an urgent indication for laparotomy, 35% to 45% were found to have no peritoneal penetration and laparotomy could be avoided[27]. Laparoscopy has pitfalls. Patients may develop a tension pneumothorax because of occult diaphragm injuries. In addition small bowel injuries were missed on laparoscopic examination in many series[26]. The cost-

effectiveness of laparoscopy is also a matter of concern. Despite these pitfalls, the benefits offered by minimally invasive surgery, in terms of avoiding negative or non-therapeutic laparotomy and decreasing hospitalisation, are believed to be sufficiently important to deserve continued consideration in the management of trauma.

We therefore propose that in patients with an isolated extra-peritoneal rectal injury, with either no or equivocal signs of peritonitis, that a laparoscopic examination under general anaesthesia be performed to exclude any intra-peritoneal injuries. If the laparoscopic examination is normal and no intra-peritoneal injuries are detected, a diverting sigmoid loop colostomy should be fashioned through an abdominal wall trephine.

This regimen was introduced in 1995. The major advantage of laparoscopy and diverting loop colostomy is that the patient is spared a major laparotomy wound. This allows for earlier mobilisation, fewer respiratory complications, earlier stoma education and a shorter hospital stay as shown in this series.

In summary, the conventional treatment of rectal injuries, either intra- or extra-peritoneal is an explorative laparotomy, repair if technically feasible, and routine faecal diversion with a colostomy proximal to the injured rectum. The injury is repaired if it is intra-peritoneal, or if an extra-peritoneal injury is amenable to repair or is converted to an intra-peritoneal injury as a result of mobilisation to repair other injuries.

From the results of this small series of sixteen patients, we propose the following new management strategy in patients with suspected isolated extra-peritoneal rectal injury (*Fig. 8*):

Patients with a suspected isolated extra-peritoneal rectal injury with minimal or no

abdominal signs of peritonitis should be managed as follows:

1. A digital rectal examination (DRE) should performed and supplemented with a proctosigmoidoscopic examination in patients with a negative DRE and those patients with a high index of suspicion of a rectal injury. In patients with a positive DRE, the proctosigmoidoscopic examination should be performed under anaesthesia.

2. A urinary tract injury has to be to be excluded in all patients with either macroscopic or microscopic haematuria with an intravenous pyelogram (IVP) and cystogram. An injury to the urinary tract detected by cystogram/IVP excludes the patient from this management protocol. In addition, patients with a combined extra-peritoneal bladder and extra-peritoneal rectal injury are excluded and undergo operative treatment.

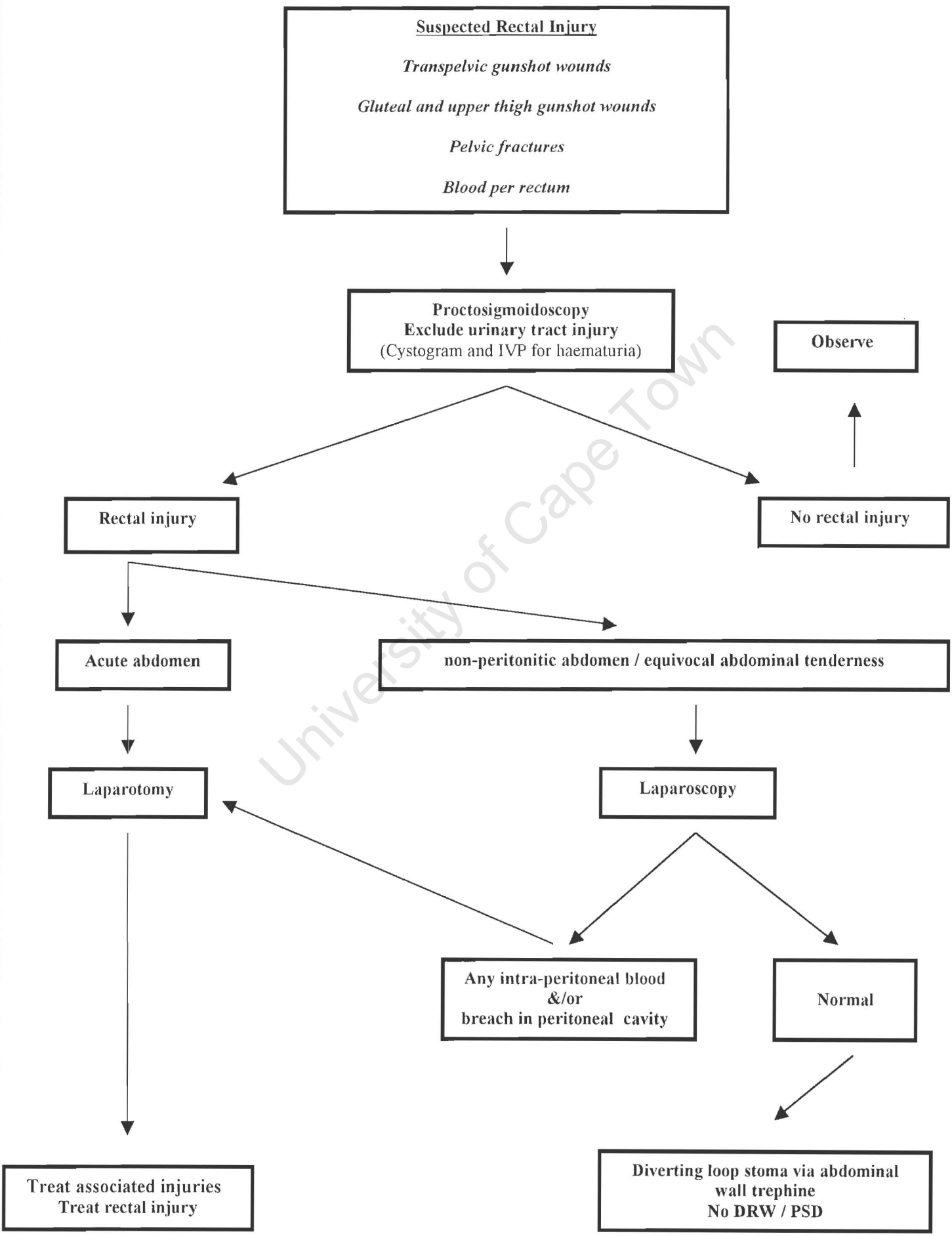
3. A diagnostic laparoscopy (DL) is performed under general anaesthesia to exclude any intra-peritoneal injuries. The presence of any intra-peritoneal blood or peritoneal breach detected at laparoscopy results in the patient undergoing an explorative laparotomy. A negative laparoscopic examination saves the patient a laparotomy.

4. Following a negative DL, a sigmoid diverting skin-level loop colostomy is fashioned in the left iliac fossa through an abdominal wall trephine.

5. No rectal washout or presacral drainage is performed

This protocol regimen has been used in this small retrospective series of 16 patients, and has been shown to be a feasible option in the management of isolated extra-peritoneal rectal injuries.

Fig. 8 Management Algorithm for Isolated Extra-peritoneal Rectal Injuries



ACKNOWLEDGMENTS

I am deeply appreciative of Professor Del Kahn, my supervisor, in sharing his extensive expertise and guidance in making this thesis possible.

I am also indebted to Sister Priscilla d'E Stevens and her thorough recording of data from which all the information required in making this study possible could be retrieved.

Finally, I am indebted to the Groote Schuur Hospital, Trauma Unit; the present head, Dr Andy Nicol and the past chiefs of the unit, Dr's Johan van der Spuy and Peter Bautz; and especially to the surgical registrars who have provided an environment that makes the practice of trauma surgery exciting and whose encouragement and questioning minds have challenged one to seek better solutions to difficult surgical problems.

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