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Gunshot wounds of the colon: role of primary repair

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This is a prospective study of 100 patients with bullet injuries of the colon. Primary repair was performed except in cases of severe colonic damage requiring colectomy or in the presence of disseminated gross peritoneal contamination. Primary repair was performed in 76% with an incidence of abdominal sepsis of 11.8%. The remaining 24% of the patients had a colostomy and the incidence of abdominal sepsis was 29.2% ($P<0.05$). Left-sided colonic injuries, multiple colonic perforations, shock on admission, delay >6 h, more than two associated intra-abdominal injuries, high Injury Severity Score (ISS), and high Penetrating Abdominal Trauma Index (PATI), are not in themselves contraindications for primary repair.

The management of civilian colonic injuries has undergone significant changes in the last few years. There is ample evidence to support primary repair in most civilian colonic injuries. However, there is still strong resistance against primary repair in gunshot wounds (GSW). It has been our policy not to distinguish between knife and gunshot injuries of the colon. We present our results in a prospective study of 100 cases with gunshot wounds of the colon. This is the first study exclusively devoted to this type of colonic trauma.

Methods

This was a prospective study and it was performed at Baragwanath Hospital, Johannesburg, over a period of 18 months (1989–1990). Candidates for inclusion in the study were all patients with bullet injuries of the colon.

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Excluded from the study were patients who died within 48 h of operation. These patients died for reasons unrelated to the colonic wounds, usually due to massive bleeding from other associated injuries. Their short survival precluded assessment of the safety of the type of colonic management used.

The standard approach to the injured colon was débridement and primary repair of the perforations (two layers, synthetic absorbable suture 3/0). Colostomy was performed only if (a) the colonic damage was so extensive that a resection was deemed necessary, and (b) there was disseminated gross faecal contamination or pus. In this case the perforation was exteriorised as a colostomy whenever possible or the perforation was repaired and a proximal loop colostomy was performed. A closed drain was used depending on the judgement of the surgeon. The incision wound was closed routinely. Shock on admission, multiple intra-abdominal injuries, multiple colonic perforations, the anatomical site of the colonic injury (left or right colon), delay of more than 6 h, and high ISS or PATI, were not taken into account when deciding primary repair or colostomy. All patients received a cephalosporin for 48 h (starting before the operation).

The patients were monitored postoperatively for any evidence of abdominal sepsis. An abdominal wound was defined as infected if there was pus, exudate with positive cultures, or erythema requiring antibiotics or opening of the wound. An intra-abdominal abscess was suspected clinically and echographically and confirmed by percutaneous aspiration or operation. The patients were followed up for a minimum period of 10 days after the operation.

The following parameters were assessed and recorded: The Revised Trauma Score (RTS) *(1)* on admission, the Injury Severity Score (ISS) *(2)* and the Penetrating Abdominal Trauma Index (PATI) *(3)* as estimated at

Table I. ISS and PATI in 100 GSW of the colon

	No. of patients		*No. of patients*
ISS <15	0	PATI <15	16
ISS 16–20	1	PATI 16–25	47
ISS 21–25	0	PATI 26–35	29
ISS 26–30	75	PATI 36–45	7
ISS 31–35	16	PATI >45	1
ISS 36–40	0		
ISS >41	8		

operation. (ISS > 16 signifies severe trauma, with an ISS 20–40 the patient is considered as critical but salvageable. With a PATI > 25 the morbidity escalates significantly (*3*).) The probability of survival for each patient was estimated with the TRISS methodology. The TRISS index is estimated from the RTS, the ISS, the type of injury (blunt or penetrating) and the age of the patient (*4*). Using the TRISS index, the outcome of a group of patients can be compared with the outcome in similar patients treated in major American trauma centres.

Patients

A total of 100 patients fulfilled the criteria for inclusion in the study and analysis. There were 97 males and 3 females. The mean age was 28.3 years. All patients had bullet injuries of the abdomen, but no attempt was made to distinguish between low-velocity and high-velocity missiles on admission. Six cases had two or more abdominal GSW. There were 17 patients in shock on admission (BP < 90 systolic). The RTS ranged from 4.09 to 7.84 (median 7.84). The transverse colon was involved in 57 cases, the left side of the colon in 48 cases, and the right colon in 22 cases. There was involvement of two or more colonic segments in 27 patients. A total of 78 patients had two or more colonic perforations. In 42 cases there were three or more intra-abdominal organ injuries. The most commonly associated intra-abdominal injury was the small bowel in 50% of the patients, followed by the liver in 18%, the stomach in 16%, the duodenum 7%, the pancreas 6%, the spleen 5%, major vessels 5%, the kidney 5%, the biliary tract 3%, the bladder 2%, and the ureter 1%.

The PATI was >25 in 43 cases and <25 in the remaining 57 cases. The ISS was higher than 16 (signifying severe injury) in all patients. In fact the ISS was >26 in all but one patient who had an ISS of 20 (Table I).

Operative management

Primary repair was performed in 76 patients (76%), a Hartmann's procedure in 16 patients (16%), and repair of the wound with a proximal colostomy in eight patients (8%). Overall, 90.5% of the patients who did not require resection of the colon, were treated by primary repair.

Of the 78 patients with multiple colonic wounds, 59 (75.6%) were treated by primary repair, 16 (22.5%) by Hartmann's procedure, and 3 (3.9%) with repair and proximal loop colostomy. Of the 62 patients with multiple colonic perforations who did not require resection, 95.2% were managed with primary repair.

In the group of 42 patients with three or more associated intra-abdominal injuries, 33 (78.6%) were managed with primary repair, 6 (14.3%) with Hartmann's procedure, and 3 (7.1%) with a loop colostomy. Of the 36 patients with multiple associated injuries who did not require colectomy, 33 (91.7%) were treated with primary repair.

Morbidity and mortality

There were two deaths, but neither of them was due to abdominal sepsis. One patient with associated spinal cord injury and another patient with associated severe head injury, died 7 and 6 days postoperatively. Both patients had a Hartmann's procedure. Post-mortem examination showed no evidence of intraperitoneal sepsis.

The overall incidence of abdominal septic complications was 19% (19 cases). Severe intra-abdominal complications occurred in 5% (two intra-abdominal abscesses, three fistulas). One of the abscesses was managed with percutaneous aspiration, and all three fistulas were successfully treated conservatively. The remaining complications were superficial sepsis (Table II). The incidence of abdominal sepsis in the group of patients who had primary repair was 11.8% compared with 29.2% in the group with a colostomy ($P < 0.05$, Fisher's exact test).

In the group of 76 patients with primary repair, there were three cases (4%) of intra-abdominal complications (one abscess, two fistulas). One of these patients had four perforations of the colon, two perforations of the stomach, and a transected splenic vein. He developed an abscess away from the colonic perforation, over the lumbar spine, which was managed successfully with percutaneous aspiration. The two cases who developed fistulas had relatively small injuries, with a PATI of 16 and 15, respectively, and both had an ISS of 26 (Table III).

The most severe septic complication occurred in a patient with a loop colostomy. He developed peritonitis postoperatively and required another two operations; his

Table II. Abdominal complications

	No. of patients	*Intra-abdominal sepsis*	*Fistulas*	*Wound sepsis*	*Bullet tract sepsis*
Primary repair	76	1	2	6	2
Hartmann's procedure	16	0	1	5	1
Loop colostomy	8	1	0	0	0
Total	100	2 (2%)	3 (3%)	11%	3%

Table III. ISS and PATI in patients with intra-abdominal complications

Case	*Type of operation*	*Complication*	*ISS*	*PATI*
1	Loop colostomy	Peritonitis	35	33
2	Primary repair	Abscess	26	35
3	Primary repair	Fistula	26	16
4	Primary repair	Fistula	26	15
5	Hartmann's procedure	Fistula	26	24

hospitalisation period was 70 days. This patient had a PATI of 33 and and ISS of 35.

Of the five patients who developed severe intra-abdominal complications (sepsis or fistulas), three had a PATI score <25 and the remaining two had a PATI >25 (Table III).

The entire group of patients was studied with the TRISS methodology. The *M* value was 0.95 signifying a patient population comparable to that in the main database. The *Z* value was -1.61. A negative *Z* value indicates that less died than predicted from the base set. Absolute values of $Z<1.96$ are not statistically significant.

Discussion

The management of civilian colonic injuries has undergone a significant change during the last few years. The old dogma that primary repair is safe in the right colon but not in the left colon has been discredited. No clinical or experimental study has ever shown that the two sides of the colon heal differently. On the contrary, there is evidence that no distinction should be made between right and left colonic injuries *(5–7)*. Despite the new approach to colonic injuries there is still significant reluctance to perform primary repair in many cases. Various criteria for primary repair have been described over the years: no shock on admission, no more than two associated intra-abdominal injuries, no multiple colonic injuries, no bullet injuries, no gross contamination, theatre delay less than 6 h, and a PATI <25. We are convinced that almost all the above criteria are not valid. We perform primary repair in all cases except in those with severe colonic damage requiring resection or in the presence of severe gross faecal contamination or pus. In penetrating injuries of the colon we performed primary repair in 88% of cases *(8)*. In the current series with GSW, primary repair was performed in 76% of all cases or 90.5% of patients not requiring resection. This is the highest primary repair rate reported in the literature (Table IV). In most series which recommend primary repair, primary repair was achieved in between 44% and 64% *(9–13)*.

We manage bullet injuries in the same way as knife injuries. We do not try to establish from the history the velocity of the bullet; the extent of damage is assessed at operation and the appropriate procedure is performed.

Table IV. Reported intra-abdominal complications in colonic injuries

Ref.	*Primary repair (% of cases)*	*Intra-abdominal abscess*	*Faecal fistulas*
9	49%	12%	4%
10	52.4%	9%	1.1%
11	64%	7.1%	?
12	44.3%	9.2%	0.4%
13	44%	3.5%	?
14	63.3%	8.5%	3.1%
15	38.3%	12.7%	3.2%
Present	76%	2%	3%

The presence of multiple colonic perforations is not a contraindication for primary repair. Of the 78 patients with multiple colonic wounds, 59 (75.6%) were managed with primary repair. Only one patient developed intra-abdominal sepsis. This particular patient developed an abscess near the lumbar spine at the site where the bullet had been lodged and away from any colonic suture line. Similarly, the presence of multiple intra-abdominal organ injuries is not a contraindication for primary repair. Of the 42 patients with three or more organ injuries, primary repair was performed in 34 (80%). There was only one case of intra-abdominal abscess (the patient described above).

The presence of shock on admission is not a contraindication for primary repair. Of the 17 patients admitted in shock, 10 (58.8%) were managed with primary repair. One patient developed a fistula which closed spontaneously.

Shannon and Moore *(9)* suggested that intra-peritoneal primary repair should be reserved for patients with an Abdominal Trauma Index less than 25. However, their results do not justify this suggestion. They found that ATI >25 was associated with a high incidence of colon-related complications irrespective of treatment modality. However, they had no evidence to suggest that primary repair is contraindicated. Our findings do not support their recommendation. A total of 24 patients with PATI >25 had primary repair of the colon with only 1 (4.2%) intra-abdominal complication (abscess). Fifty-two patients with PATI <25 had primary repair and there were 2 (3.8%) complications (two faecal fistulas). We think that PATI has no value in determining the type of operation for colon injuries.

Similarly, the ISS did not have any significance in deciding primary repair or colostomy. An ISS 20–40 is considered critical but salvageable condition. In this series, all but one patient had an ISS >26 (Table III). Primary repair in this group was not associated with a higher incidence of abdominal sepsis than the group of patients who had a colostomy (4% *vs* 8.3% NS).

Our overall incidence of intra-abdominal abscesses was 2% and the incidence of faecal fistulas was 3%. These figures compare very favourably with other series, especially taking into account that all our patients were

GSW victims. The reported incidence of intra-abdominal abscess is 7–12% , and the incidence of fistulas is 1–4% (Table IV). It seems that the higher the percentage of patients treated by primary repair, the lower the incidence of intra-abdominal abscesses (Table IV). A colostomy is an open source of faeces near a laparotomy wound and with a potential communication with the peritoneal cavity through its abdominal wall exit. Theoretically it should be associated with a higher incidence of wound sepsis and intra-abdominal abscesses. Our overall mortality was less than predicted with the TRISS methodology. Most probably this is due to our policy of liberal primary repair.

In conclusion, the majority of GSW of the colon can safely be managed by primary repair. Left-sided injuries, multiple colonic perforations, shock on admission, delay >6 h, high ISS or PATI, and more than two associated intra-abdominal injuries, do not appear to be contraindications for primary repair.

References

1 Champion HR, Sacco WJ, Copes WS *et al.* A revision of the trauma score. *J Trauma* 1989;**29**:623–9.

2 The American Association for Automotive Medicine. The abbreviated injury scale. Revised edition. Illinois: Des Plaines, 1985.

3 Moore EE, Dunn EL, Moore JB, Thompson JS. Penetrating Abdominal Trauma Index. *J Trauma* 1981; **21**:439–45.

4 Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. *J Trauma* 1987;**27**:370–8.

5 Demetriades D, Rabinowitz B, Sofianos C, Prumm E. The management of colon injuries by primary repair or colostomy. *Br J Surg* 1985;**72**:881–3.

6 Falcone RE, Carey LC. Colorectal trauma. *Surg Clin North Am* 1989;**68**:1307–18.

7 Demetriades D, Lawson HH, Sofianos C, Oosthuizen M, Kurstjens S, Frolich J. Healing of the right and left colon: an experimental study. *S Afr Med J* 1988;**73**:657–8.

8 Demetriades D, Lakhoo M, Pezikis A, Charalambides D, Pantanowitz D, Sofianos C. Short-course antibiotic prophylaxis in penetrating abdominal injuries: ceftriaxone versus cefoxitin. *Injury* 1991;**22**:20–24.

9 Shannon FL, Moore EE. Primary repair of the colon: when is it a safe alternative? *Surgery* 1985;**98**:851–9.

10 Burch JM, Brock JC, Gevirtzman L *et al.* The injured colon. *Ann Surg* 1986;**203**:701–11.

11 Adkins RB, Zirkle P, Waterhouse G. Penetrating colon trauma. *J Trauma* 1984;**24**:491–9.

12 Levison MA, Thomas DD, Wieniek RG, Wilson RF. Management of the injured colon: evolving practice at an urban trauma centre. *J Trauma* 1990;**30**:247–53.

13 Baker LW, Thomson SR, Chadwick SJD. Colon wound management and prograde colonic lavage in large bowel trauma. *Br J Surg* 1990;**77**:872–6.

14 Beall AC, Bricker DL, Alessi FJ *et al.* Surgical considerations in the management of civilian colon injuries. *Ann Surg* 1971;**173**:971–8.

15 Garfinkle SE, Cohen SE, Matolo NM, Getzen LC, Wolfman EF. Civilian colonic injuries. *Arch Surg* 1974; **109**:402–4.

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Book review

The Management of the Diabetic Foot by Irwin Faris. 200 pages. Churchill Livingstone, New York. 1991. £17.50. ISBN 0 443 04249 7

Immediately on picking up this book, one feels as though it is going to be a friend for life. The concise, succinctly written chapters encompass all aspects of diabetic disease affecting the foot. It begins with a history of diabetes and its complications, and proceeds with a well-referenced and well-written chapter on the mechanisms of foot lesions. Pamela Le Quesne and Nicholas Parkhouse, members of the Department of Neurological Sciences at the Middlesex School of Medicine, London, are contributors to the section on the Neuropathic Foot.

As the book concludes, the outlook for patients with major foot lesions and diabetes is not good. This, however, should not deter the clinician looking after them from endeavouring to provide the maximum care and attention and limb salvage possible.

This paperback edition will certainly aid those already established in management of diabetic foot problems, and certainly is an essential volume for medical students and nurses struggling to understand this most complex condition. With this in mind, it is very well priced.

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