Selective non-operative management of ballistic abdominal solid organ injury in the deployed military setting

AM Wood[1], K Trimble[2], MA Louden[3], J Jansen[4]

[1]Specialty Registrar 3 in Orthopaedics & Trauma, Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh; [2]Consultant Orthopaedic & Trauma Surgeon, MDHU Derriford, Derriford Hospital, Plymouth; [3]Consultant General Surgeon, 306 Hospital Support Medical Regiment, Royal Army Medical Corps (V); [4]Consultant General Surgeon, 144 Parachute Medical Squadron, 16 Medical Regiment, Royal Army Medical Corps (V)

Abstract

This article describes the non-operative management of five patients with ballistic abdominal solid organ injuries in a role 2E medical treatment facility. The selective non-operative management of ballistic abdominal solid organ injury is an accepted management strategy in high-volume civilian trauma centres, and appears to be equally safe and effective in the deployed military setting.

Introduction

The selective non-operative management of abdominal stab wounds is well established in civilian practice, and there is increasing evidence that the selective non-operative management of abdominal solid organ injury due to gunshot wounds is also safe [1-11]. If haemorrhage has ceased and hollow viscus injury can be excluded, non-operative management avoids the potential morbidity and mortality of laparotomy, particularly if it is non-therapeutic, and shortens hospital stay.

Although accepted in civilian trauma surgical practice in South Africa and North America, the utility of this approach has not been verified in the deployed military setting. We report five patients with abdominal solid organ injuries inflicted by military munitions, who were successfully managed without operation in a role 2E facility.

The injuries reported in this article have been graded using the American Association for the Surgery of Trauma (AAST) Organ Injury Scaling System, a classification scheme based on the degree of anatomical disruption. Grades I-V represent increasingly complex injuries encountered in salvageable patients, while Grade VI is a destructive lesion incompatible with survival [12].

Case Series

Case 1: A 6 year old male was admitted following a rocket propelled grenade explosion, having sustained an isolated wound to his right loin. He was tachycardic (147 bpm) and normotensive (120/70 mmHg). His abdomen was non-tender, and his heart rate decreased to 100 bpm following the administration of one unit of packed red blood cells, one unit of fresh frozen plasma, and approximately one litre of normal saline. Computed tomography (CT) (Figure 1) revealed a 1 cm metal fragment in segment 6 of the liver (Grade II), a track passing from the wound in the right loin, through the right kidney (Grade III), minimal free fluid and no free air. The patient underwent debridement of his loin wound. He was discharged to the local International Committee of the Red Cross (ICRC) hospital three days after admission, with instructions to continue oral co-amoxiclav therapy for a total of five days.

Corresponding Author: J Jansen, Consultant Surgeon, Aberdeen Royal Infirmary, Foresterhill, Aberdeen AB25 2ZN
Email: j.o.jansen@gmx.com

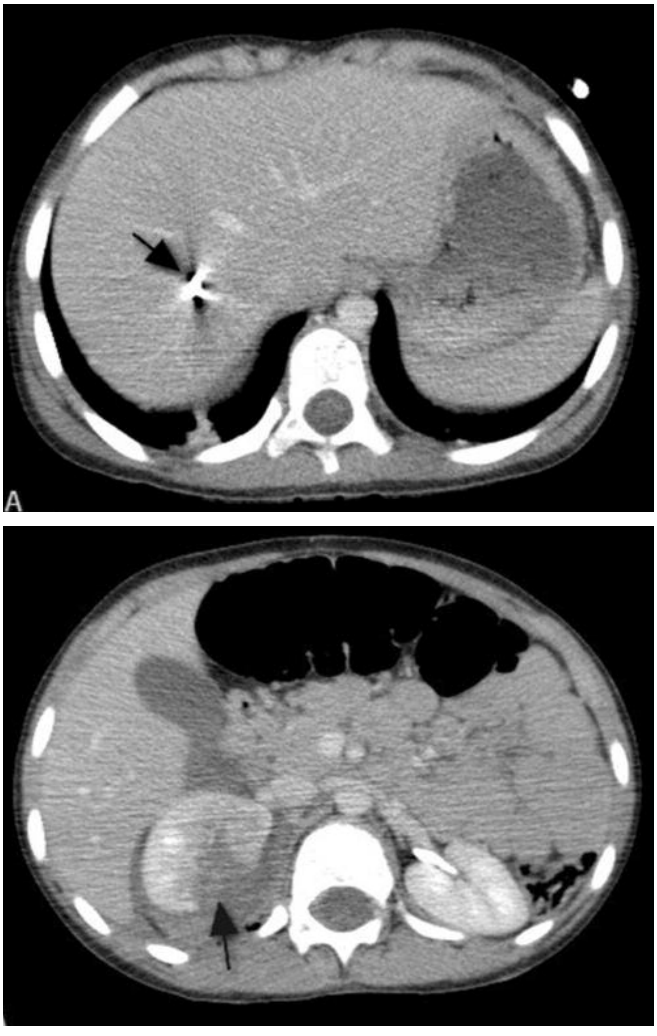

Figure 1. *Fragment in segment 6 of liver (top, arrowed) and grade 3 renal injury (bottom, arrowed)*

Case 2: An 18 year old male was admitted following a gunshot wound to the right chest. Two wounds were identified; one in the mid-clavicular line, over the costal margin, the other immediately posterior to the mid-axillary line, at the level of the 10th rib. The patient had been intubated and had had an intercostal drain placed

in the field. On arrival, he was tachycardic (110 bpm) but normotensive (110/70 mmHg). Following administration of two units of packed red blood cells, two units of fresh frozen plasma, and one litre of Hartmann's solution, his heart rate decreased to 65 bpm. CT of the chest and abdomen revealed a well-positioned intercostal drain, extensive surgical emphysema, a small residual haemopneumothorax, a Grade III liver laceration involving segments 6 and 7, free fluid throughout the abdomen, but no free intraperitoneal air (Figure 2). The patient underwent debridement of wounds, was extubated the following day, and transferred to the ICRC hospital 48 hours later, with instructions to continue co-amoxiclav therapy for a total of five days.

Figure 2. *Grade III liver laceration (black arrows). Note free fluid throughout abdomen (white arrow).*

Case 3: A 20 year old male was admitted following a gunshot wound to the right chest. Examination revealed a wound over the lower lateral chest wall, and a further wound overlying the transverse process of L1. The patient was tachycardic (160 bpm) but normotensive (120/70 mmHg) and responded to resuscitation with four units of packed red cells, four units of fresh frozen plasma, and placement of an intercostal drain. He was tender over the right side of his abdomen. There was no neurological deficit. CT of the chest and abdomen showed a small residual haemopneumothorax, a Grade IV liver laceration (Figure 3), a Grade III right renal laceration, a large right zone II (lateral) retroperitoneal haematoma, and abdominal free fluid (Figure 3). There was some retroperitoneal, but no intraperitoneal, free gas. The patient was given co-amoxiclav, underwent debridement of his wounds, and was discharged to the ICRC hospital five days after injury.

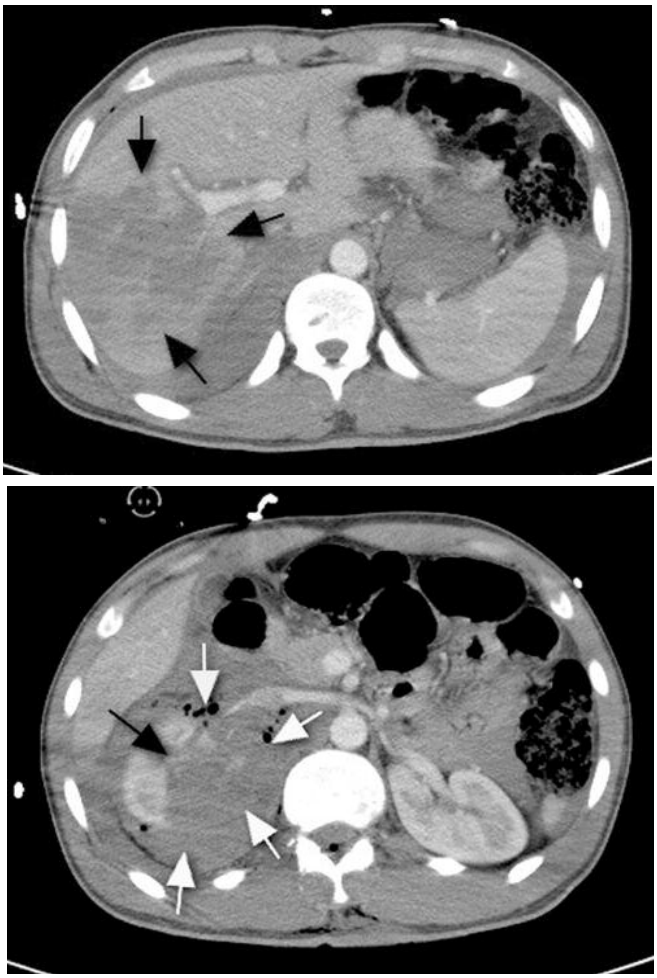

Figure 3. *Grade IV liver laceration (top, black arrows), Grade III right renal laceration (bottom, black arrow). Note also the retroperitoneal haematoma and air (white arrows) and free abdominal fluid.*

Case 4: A 32 year old male was admitted following an improvised explosive device explosion. Examination revealed an isolated wound in his right loin. He was tachycardic (127 bpm) and hypotensive (96/72 mmHg) but responded rapidly to the infusion of two units of packed red cells and two units of fresh frozen plasma. Plain film radiology (Figure 4) showed a bolt in the abdomen, and CT (Figure 5) confirmed its position in the retroperitoneum, superomedial to the right kidney, associated with a Grade II injury, and a large zone II (lateral) haematoma displacing the duodenum anteriorly. There was no intraperitoneal free air. The patient was given co-amoxiclav and observed. His recovery was complicated by opiate withdrawal, and he discharged himself against medical advice three days after injury.

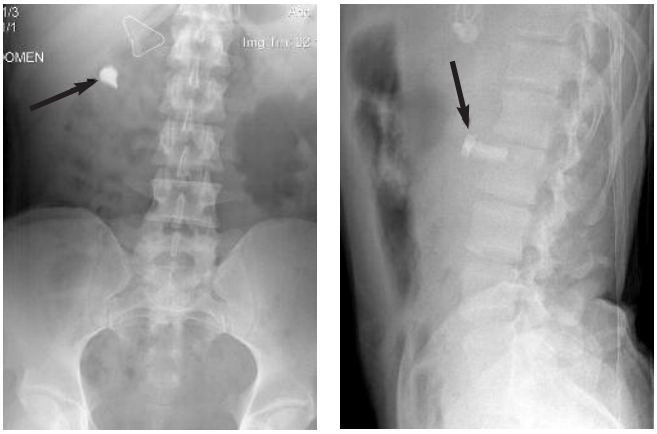

Figure 4. *Plain film radiography showing bolt in right abdomen (arrowed). The paper clip marks the entry wound on the patient's back.*

Figure 5. Note bolt adjacent to right kidney (top, arrowed), surrounded by zone II retroperitoneal haematoma (bottom, arrowed).

Case 5: A 27 year old male was admitted following a gunshot wound to the right chest with an entry wound at the level of the costal margin in the mid-clavicular line and exit at approximately fourth rib level in the mid-axillary line. On admission the patient was tachycardic (110 bpm) with a blood pressure of 110/60 mmHg, and complaining of upper abdominal tenderness. Following intercostal tube placement, with immediate drainage of 500 ml of blood, and resuscitation with 1 litre of normal saline and 2 units of packed cells, the patient was stable enough for CT. This showed moderate free intraperitoneal blood, but no free air, and a Grade III liver injury (Figure 6).

The patient was taken to the operating theatre where the exit wound was extended and debrided with ligation of bleeding intercostal vessels. There was no evidence of ongoing intrathoracic haemorrhage. The entry wound was simply excised. A formal closure of the chest wall was undertaken, leaving skin open. Delayed primary closure was carried out at day three and the chest drain removed. The patient was discharged well on day five post wounding.

Figure 6. *Grade III liver injury (segment 6 and 7) (arrowed).*

Discussion

Several civilian case series from South Africa and the USA (Table 1), have shown that the selective non-operative management of ballistic abdominal solid organ injury is safe [1-11]. These reports describe between four and 144 patients with low energy-transfer gunshot wounds who were managed without operation. Some of these studies included patients with tangential wounds, and the earliest series, published prior to the advent of cross-sectional imaging, relied on clinical examination alone [1,2]. As expected, the number of patients with confirmed solid organ injury who can be managed conservatively is small (Table 1), but there nevertheless appears to be an important subset of patients who can be spared operative treatment. Right sided renal injuries, as in this series, are often associated with hepatic injuries (3,9).

The five cases reported here, all of whom had confirmed solid organ injuries, suggest that selective non-operative management is also safe in the military setting. The nature of ballistic trauma inflicted by military munitions and the limited resources and number of personnel available in deployed medical treatment facilities usually mandate a more liberal approach to exploration. Although seemingly prudent, such a strategy is, however, not without potential cost: Operative treatment of the cases described above may have resulted in nephrectomy in two patients, and could have precipitated significant haemorrhage in all five as laparotomy released the tamponade effect, with further transfusions of scarce blood products. Moreover, control of haemorrhage in such circumstances may have necessitated the use of limited resources involving the use of damage control techniques, intensive care facilities and complex further surgery, which presents its own problems at times of sustained high operational tempo and casualty flow. Non-operative management avoided these sequelae.

This series has undoubted limitations. Numbers are small and, for operational reasons, follow-up was limited to a few days, which – although probably sufficient to exclude missed hollow viscus injuries – is too short to detect many other complications. All five patients were young and without comorbidity.

The probable trans-diaphragmatic trajectory in four of the patients raises the possibility of late herniation, but given the right-sided nature of the injuries, was not pursued further. Bowel injury is the Achilles' heel of non-operative management, and is less likely when the trajectory appears to be confined to the retroperitoneum and solid viscera, as in our patients.

High quality imaging is an indispensable adjunct to the decision making process when contemplating non-operative management. CT is the investigation of choice, as it can demonstrate the trajectory, delineate the extent of solid organ damage, and exclude – with reasonable certainty – associated hollow viscus injury, although there are no studies specifically addressing the performance of CT in this regard. CT is also essential for detecting the presence of acute complications such as pseudoaneurysm formation or arteriovenous fistulation, which may require laparotomy or – in the civilian setting – radiological intervention. Non-operative management of ballistic injuries without cross-sectional imaging may be appropriate in the context of very high casualty flow, in haemodynamically stable patients, but should be accompanied by frequent clinical review, and followed by either imaging or laparotomy once the operational tempo has slowed. The patients described in this report were regularly reassessed, initially at least hourly, subsequently decreased to a minimum of twice daily, by an experienced consultant surgeon.

Laparotomy remains the default treatment of ballistic abdominal injury. During the same period as the above five cases, 64 patients underwent abdominal exploration. Surgeons should approach patients who have sustained ballistic abdominal trauma with the expectation of having to operate, especially in the military setting. However, this series supports the selective non-operative management of ballistic solid organ injury as safe and resource-effective, in experienced hands, in a military setting, when supported by high quality cross sectional imaging, and combined with diligent serial examination.

Reference	Year	Centre	Injury site	Total number of patients	Number of patients initially selected for non-operative management	Number of patients managed non-operatively	Number of patients with confirmed solid organ injury	Number of patients with non-operatively managed confirmed solid organ injury
Muckart [1]	1990	Durban	Abdomen	111	22	22	N/A*	N/A*
Demetriades [2]	1991	Johannesburg	Abdomen	146	41	34	N/A*	N/A*
Renz [3]	1994	Atlanta	Right thoracoabdomen	32	13	13	8	8
Chmielewski [4]	1995	Detroit	Abdomen	185	12	11	12	11
Demetriades [5]**	1997	Los Angeles	Anterior abdomen	309	106	5	5	4
Velmahos [7]	1998	Los Angeles	Kidney	52	4	4	4	4
Demetriades [8]	1999	Los Angeles	Liver	152	16	11	16	11
Omoshoro-Jones [9]	2005	Cape Town	Liver	33	33	31	33	31
Dubose [10]	2005	Miami	Abdomen	644	144	143	13	12
Navsaria [11]	2009	Cape Town	Liver	195	63	58	63	58

** These studies relied on clinical assessment (rather than CT), and rates of solid organ injury therefore cannot be assessed*
*** Not all patients in this study underwent CT*

Table 1: *Summary of published studies of selective non-operative management of abdominal gunshot wounds*

References

1. Muckart DJ, Abdool-Carrim AT, King B. Selective conservative management of abdominal gunshot wounds: a prospective study. Br J Surg 1990; 77:652-655
2. Demetriades D, Charalambides D, Lakhoo M, Pantanowitz D. Gunshot wounds of the abdomen: role of selective management. Br J Surg 1991; 78: 220-222
3. Renz BM, Feliciano DV. Gunshot wounds to the right thoracoabdomen: a prospective study of nonoperative management. J Trauma 1994; 37: 737-744
4. Chmielewski GW, Nicholas JM, Dulchavsky SA, Diebel LN. Nonoperative management of gunshot wounds of the abdomen. Am Surg 1995; 61: 665-658
5. Demetriades D, Velmahos GC, Cornwell EE, Belzberg H, Murray J, Asensio J, Berne TV. Selective nonoperative management of gunshot wounds of the anterior abdomen. Arch Surg 1997; 132: 178-183
6. Wessells H, McAninch JW, Meyer A, Bruce J. Criteria for nonoperative treatment of significant penetrating renal lacerations. J Urol 1997; 157: 24-27
7. Velmahos GC, Demetriades D, Cornwell III EE, et al. Selective management of renal gunshot wounds. Br J Surg 1998; 85: 1121-1124
8. Demetriades D, Gomez H, Chahwan S et al. Gunshot injuries to the liver: The role of selective nonoperative management. J Am Coll Surg 1999; 188: 343-348
9. Omoshoro-Jones JAO, Nicol AJ, Navsaria PH et al. Nonsurgical management of liver gunshot injuries. Br J Surg 2005; 92: 890-895
10. Dubose J, Inaba K, Texeira PGR, Pepe A, Dunham MB, McKenney M. Selective non-operative management of solid organ injury following abdominal gunshot wounds. Injury 2007; 38: 1084-1090
11. Navsaria PH, Nicol AJ, Krige JE, Edu S. Selective nonoperative management of liver gunshot injuries. Ann Surg 2009; 249: 653-656
12. American Association for Surgery of Trauma. Organ Injury Scaling and Scoring System. http://www.aast.org/Library/dynamic.aspx?id=1322 (accessed 11 Aug 2009)