

THE MANAGEMENT OF PENETRATING ABDOMINAL INJURIES*

Comparative Military and Civilian Experiences

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HISTORICAL NOTE

THE EARLIEST REFERENCE in the literature to an abdominal wound is apparently in the *Anabasis*,¹ in which Xenophon described the plight of a Greek army captain who returned to his camp literally holding his bowels in his hands after an eviscerating wound of the abdomen. It was not until 1853, however, during the Crimean War, that any form of surgical intervention was recommended for such injuries. Then Baudens² suggested that in suspected internal injuries a small abdominal incision should be made, through which a sponge could be introduced; if the sponge returned bloody, the abdomen could be opened and the bleeding vessel ligated.

During the War between the States many surgeons on both sides spoke in favor of surgical intervention for abdominal injuries, but no one, so far as is known, acted on the advice. Available records, including one series of 3,690 cases,³ indicate that in that war the mortality of this type of injury was 90 per cent and more. In the years following the war civilian surgeons also advocated operation for abdominal injuries, but actually surgery did not then have a great deal to offer. The lack of a satisfactory anesthetic agent and the hazards of all surgery in the pre-Listerian era meant that the patient who was not operated on had about as good a chance of recovery as the patient submitted to surgery. The popular method of treatment therefore continued to be rest, starvation, and the administration of morphine.

After 1880 the voices favoring active intervention in abdominal injuries became louder. Surgical and anesthetic technics, while still crude by present-day standards, had so far advanced that laparotomy was not infrequently undertaken for abdominal and pelvic tumors, and there seemed no good reason why the same procedure should not be followed for the investigation and repair of visceral damage. The death of President Garfield September 19, 1881, from a pistol wound of the abdomen, did much to stimulate interest in active treatment for penetrating abdominal wounds, and the consensus of medical opinion was that he could have been saved by active surgical intervention.

In 1882 J. Marion Sims⁴ wrote: ". . . there is no more danger of a man's dying of a gunshot or other wound of the peritoneal cavity, properly treated, than there is of a woman dying of an ovariectomy, properly performed."

By 1887 Parkes⁵ was able to write: ". . . there are few modern surgeons, who, when confronted with a bullet wound of the abdominal walls . . . would explore the cavity. One is almost tempted to say that all cases are entitled to

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the chance of life offered through operative procedure. . . . However, if the abdominal wound is complicated or severe . . . or so great a time has elapsed as to allow . . . virulent inflammation, the probability is that the issue will be fatal."

Thereafter surgical intervention was accepted as the better form of treatment. Many surgeons began to operate for abdominal injuries, and the results were frequently encouraging. Coley in 1891⁶ reported a mortality of 67 per cent in a series of 165 abdominal injuries and Fenner in 1901,⁷ in reporting a mortality of 59 per cent in 152 penetrating abdominal wounds, remarked, ". . . despite the high mortality, I still think the indication for operation is pretty generally accepted the world over."

These results, indeed, compared favorably with the mortality of 81 per cent in the 4,958 collected cases reported by Stimson in 1889,⁸ in all of which nonsurgical measures had been employed, and with the mortality of 90 per cent for abdominal injuries in the Spanish-American War. In the Boer War, at the turn of the century, the results were not much better, but there were certain reasons why surgeons could not then resort to operation. Distances were great. The heat was a serious problem. The supply of water was limited and usually contaminated. Transportation was slow and difficult. All of these factors were so serious in themselves, or so prolonged the time interval, that operation under the circumstances offered little more hope for recovery than did expectant treatment.

The point of view concerning abdominal injuries which prevailed during the South African War also prevailed early in World War I. It was not considered practical, under conditions of war, to set up field hospitals close enough to the line of battle to receive patients within the time interval required for successful abdominal surgery. This reasoning must be evaluated before it is condemned in light of the fact that many ambulances were still horse-drawn and that the motorization of vehicles of war was in its infancy. Moreover, the military authorities were severely objective in their planning: A battle casualty with an abdominal wound was regarded as having almost as little chance of survival as if he had been killed instantly, and the effort and equipment necessary to save the few who might survive were not considered justified.

Makins,⁹ who led the group of military surgeons committed to the policy of nonintervention in abdominal injuries, expressed the viewpoint of all military surgeons when he said ". . . small gut lesions were practically always fatal, and . . . the success obtained by the 'wait and see' policy was due to the escape of the bowel, although the belly had been penetrated."

The policy of expectant treatment for abdominal injuries did not, however, remain entirely unchallenged in World War I. An occasional civilian surgeon, newly in uniform, insisted upon prompt surgical intervention. The first operation for a penetrating wound of the abdomen in that war seems to have been done in December, 1914, by Captain John Campbell¹⁰ of Liverpool, who

successfully repaired two perforating bullet wounds of the stomach. Three months later Captain Owen Richard¹⁰ successfully resected 6 feet of ileum. Other surgeons advocated similar methods, and a gratifying, though small, reduction in mortality resulted. Wallace¹¹ reported 1,200 cases treated by surgery, with a mortality of 53.9 per cent, and Lockwood and Kennedy¹² reported 500 cases, with a mortality of 51.7 per cent.

In the decade following World War I the civilian statistics for penetrating abdominal injuries showed no significant improvement over earlier statistics. Mortalities of 48.2 per cent, 59.2 per cent, 61.4 per cent and 68 per cent were reported, respectively, by Billings and Walking,¹³ McGowan,¹⁴ Oberhelman, LeCount,¹⁵ and Prey and Foster.¹⁶ The mortality in the 1,299 cases reported by Loria¹⁷ from Charity Hospital of Louisiana at New Orleans for the period 1901-1930 was 62.3 per cent.

Between 1930 and 1942, however, three highly significant developments exerted a profound effect on the management of abdominal injuries. 1. A better appreciation of the fundamental pathology and pathogenesis of shock made possible an accurate estimation of the degree, as well as the prompt application of effective treatment before irreversible changes occurred. 2. A fuller knowledge of the protein and electrolytic constituents of the body made possible the correction of deficits in these constituents at the same time that more obvious blood loss was corrected. 3. Effective chemotherapeutics and antibiotics were introduced and their employment was put upon a rational basis, with the result that infection, as manifested by peritonitis, cellulitis and pneumonia, was no longer an uncontrollable problem in the management of abdominal injuries.

Even with these new developments, however, the mortality of abdominal injuries in civilian practice, except for small series of selected cases reported by single surgeons, remained extremely high. Rippey¹⁸ in 1941 reported 369 cases treated over a 17-year period, with a mortality of 60.5 per cent; a hopeful feature was that in the 29 cases treated in 1940 the mortality had been lowered to 41.3 per cent. In 1943 Hamilton and Duncan¹⁹ reported 190 cases of gunshot wounds treated over a 10½-year period with a mortality of 51 per cent; in the cases in which surgery was done the mortality was 48.9 per cent. In the same year Elkin and Ward³ reported 238 abdominal injuries with a mortality of 50.9 per cent. Two series of cases reported about this time from Harlem Hospital²⁰ showed a slight increase in mortality of the second series, from 59.3 to 62.6 per cent, but this experience, fortunately, was not indicative of the general trend.

PRINCIPLES OF MANAGEMENT OF WORLD WAR II

During the first years of World War II reports from British surgeons in the field showed no great improvement over World War I in the mortality of abdominal injuries, which remained in the neighborhood of 60 to 70²¹ per cent. On the other hand, these statistics were far more accurate than the statistics of World War I, which usually did not take into account deaths

from shock and hemorrhage on the battlefield and which were actually somewhat higher than they seemed. In World War II the excellent system of evacuation resulted in the admission to field hospitals, and therefore to the benefits of surgery, of many men who in World War I would have died on the battlefield. There were also extenuating circumstances. As in the Boer War, transportation of the wounded over the desert areas of North Africa was difficult and hazardous, and the long supply lines, over which even water had to be brought, introduced difficulties that frequently were insuperable. To the credit of the surgeons who carried on under such tremendous handicaps it must be said that their results showed a progressive improvement and, as the war progressed, the surgical mortality for abdominal injuries in the North African Theater compared favorably with that of any other group.

By the time American Armies entered combat late in 1942, the management of abdominal injuries was fairly well standardized. It called for medical aid at the earliest possible moment, though first aid, it is true, was frequently limited merely to the administration of morphine, the application of sulfa crystals to the wound (a practice later discarded), and the application of sterile gauze pads. Whenever possible, plasma or whole blood was given before the patient reached the first medical installation.

The policy of surgery for abdominal injuries had become generally accepted by the time American Armies entered combat, and certain lessons concerning their management had also been learned. One was that while prompt operation was desirable, movement to installations in the rear, where surgery could be done, was necessarily slow under military conditions. The solution of this problem was the establishment of field hospitals far forward in the combat zone. These hospitals were equipped with surgical supplies and were staffed with competent surgical personnel, so that shock could be treated adequately and extensive surgical procedures of urgent character could be performed on any part of the body.

A second lesson which was learned early in the war was that casualties with abdominal injuries did not tolerate early transportation after operation. Field hospitals were therefore equipped and staffed to hold such patients for at least 10 days after surgery, and longer if necessary, and an important factor in the earlier mortality of abdominal injuries was thus practically eliminated.

A third lesson of the early days of the war was a realization of the importance of triage at the level of the clearing station. The choice of the right time for surgery on the right patient must be credited with a large portion of the salvage of casualties which distinguished World War II.

In contrast to earlier practice, no wounded soldier in World War II was ever denied the possible benefits of surgery because his condition was regarded as poor, or even as hopeless. If he could be brought to the operating room alive he was given whatever chance he might have. In general, this policy increased the surgical mortality, because in many instances such patients died on the operating table or within a few hours after operation. On the other

hand, the almost miraculous recoveries which sometimes occurred were full justification for it.

RESUSCITATION

The time interval between wounding and operation was kept at an astonishingly low level, the average being 10 to 12 hours, but the brief lapse was not regarded as the most important consideration in the management of abdominal injuries. Patients with active, massive hemorrhage were operated on as promptly as possible, but in the absence of such bleeding, time was deliberately taken to administer blood, plasma and electrolytes according to the indications of the special case. During this interval dirty battlefield clothing was removed, body heat was restored, sedatives were administered, and such diagnostic procedures were carried out as would determine accurately the location and extent of the abdominal injuries. The special shock teams responsible for resuscitation played a major role in the reduction of the mortality of abdominal injuries in World War II.

TECHNICAL CONSIDERATIONS

All the important technical points in the management of abdominal injuries have been described numerous times and need not be repeated in any detail. Operations were performed expeditiously according to a definite plan, which reduced the percentage of error and the working time to a minimum. Shock therapy was continued throughout the procedure and until all danger of hemorrhage and peritonitis had passed.

The management of wounds of the colon and rectum, however, provided one of the outstanding contributions of military surgery in World War II. The basic principles of therapy were (1) routine exteriorization of the traumatized bowel whenever it could be sufficiently mobilized to bring it outside of the abdomen, and (2), the subsequent use of the segment as a colostomy. When mobilization was not possible, proximal loop colostomy was employed. No attempt was ever made to repair simple perforations of the colon, and resection was regarded as preferable if the damage was extensive. Resection was the method of choice for the treatment of injuries of the right side of the colon, especially if the terminal ileum was also damaged.

Injuries of the extraperitoneal portion of the colon and of the rectum were never left untreated, no matter how inconsequential they might seem. Infected fistulas which followed improper treatment were particularly serious if the pelvic bones had been damaged; osteomyelitis was then an almost inevitable consequence. The lesson was finally learned that complete diversion of the fecal stream was essential in all injuries of these portions of the large bowel, and it was also found that this could be accomplished only by some method which separated the colonic stoma or which closed the opening in the distal loop, or by providing a second colostomy in the proximal (transverse) loop of colon.

Colostomy had been suggested as a method of treating injuries of the colon in World War I but seems not to have been used except in the most serious

cases. The result was that the method was in ill repute even before it had had a fair trial. In the interval between the wars, civilian surgeons frequently brought certain tumors of the bowel outside of the abdominal cavity and created a spur colostomy, which required crushing at a later date to reestablish continuity of the bowel. The same procedure was obviously adapted to military usage, and the military surgeons of World War II were in a receptive mood for it, in view of the extremely high mortality which other methods of treatment had previously accomplished. It is to the Surgical Consultant of the British Army, Sir H. G. Ogilvie,²² that the chief credit is due for insisting upon routine exteriorization of the wounded colon with colostomy, as well as the use of colostomy for all injuries of the rectum and extraperitoneal colon. These methods were found highly effective in the treatment of casualties of the first air raids over England, and they were carried over into the North African and Mediterranean Theaters by the British military surgeons. American surgeons used the same methods without, however, knowledge of the British practice, from the time of the first landings in North Africa in November, 1942, and they were soon thereafter made the official practice.

Colostomies were usually closed in the general hospitals of the Zone of Interior. The operation was at first undertaken with a good deal of timidity, for military surgery is not civilian surgery and there was justifiable doubt as to how the stoma had been created, a doubt which the information on field medical cards did relatively little to dispel. At first spurs were crushed outside of the peritoneum, as in civilian practice, but the results were not good. Many times the spur was short and inadequate and sometimes it was non-existent. The application of a clamp or enterotome was therefore dangerous as well as painful. Moreover, rotation of the loops, sometimes for as much as 180°, was often noted, and mesentery and loops of intact bowel were often found interposed between the colostomy loops. Hemorrhage and necrosis of the bowel wall also occurred.

Extraperitoneal closure of a colostomy created under battle conditions was obviously not parallel to closure of a colostomy created under civilian conditions, but originally there was doubt as to the safety of the intraperitoneal technic. As experience accumulated, however, it became evident that this technic was considerably less dangerous than the more or less blind extraperitoneal technic. Apparently the peritoneal cavity could be entered with impunity, probably because the peritoneal tissues had been vaccinated against infection by the reaction which occurred following injury. During the latter part of the war, therefore, it became routine to open the peritoneum widely, release adhesions, repair the bowel by an end-to-end or lateral anastomosis, and replace the colon into its normal position. The results were uniformly good. Complications were few, and the mortality in some series of cases was less than 0.5 per cent.

MORTALITY

The principal causes of death in abdominal injuries were shock, hemorrhage, peritonitis and pulmonary complications, in that order of frequency. As

Ogilvie²² well expressed it, deaths which occurred in the first two hours after wounding were due to hemorrhage, in the first two days to shock, and in the first two weeks to infection. The majority of deaths occurred within 48 hours of wounding, and it was soon evident that patients who could not be brought into field hospitals within that period had very little chance of recovery. On the other hand, while the time factor was important, the so-called multiplicity factor was found to be even more important: A patient's chance of survival depended upon the number of organs injured, the mortality rising progressively as the number of injured viscera increased.

Less frequent causes of death included ileus, thrombo-embolism, intestinal obstruction, chronic, sepsis, lung abscess, liver abscess, subphrenic abscess, gas bacillus infection, hemopneumothorax and meningitis. All these complications were managed by the methods usually employed in civilian practice.

The Second Auxiliary Surgical Group, which saw active service in Italy, France and Germany, treated more than 3,500 abdominal wounds with a gross mortality for the surgical cases of 25.5 per cent.²³ From the 38th Evacuation Hospital, which also saw active service, Imes²⁴ recorded a mortality of 20 per cent for 358 abdominal injuries treated surgically. Bradford and Campbell²⁵ reported a mortality of 16.7 per cent for 443 operations, while Rohlf and Snyder²⁶ recorded the extraordinarily low mortality of 11.9 per cent in 67 cases.

THE APPLICATION OF MILITARY EXPERIENCES TO CIVILIAN SURGERY

The military experiences of World War II proved clearly that the mortality of penetrating wounds of the abdomen can be lowered drastically by proper surgical procedures. There seems no reason why similarly good results should not be achieved in civilian surgery for the same conditions. It is true that in the Army, surgeons were dealing with young, healthy adults, in the prime of physical condition, though that advantage was frequently offset by the fact that the men were tired, often to the point of exhaustion, that they were dirty, that in some instances they had not bathed for weeks, that they were likely to be dehydrated, and that frequently they were none too well nourished because they had lived on limited rations, sometimes for long periods of time. Moreover, many other circumstances were unfavorable, including difficulties of transportation, often under enemy fire, hospitals that, however well equipped, were necessarily makeshift, and personnel that was frequently in short supply.

An analysis of abdominal injuries in civilian practice reveals, on the other hand, numerous favorable factors. Most patients who suffer this type of injury are young adults, who are seldom more than 40 years of age. They are likely to be physically active. They live in city districts, where ambulance service is prompt, hospitals are near at hand, and medical supplies and personnel are plentiful.

That a gratifying decrease in the mortality of abdominal injuries can be achieved in civilian practice has already been demonstrated. In 1944 Sloan²⁷ reported from the Johns Hopkins Hospital a mortality of 14.3 per cent in a

series of 59 cases treated after 1939, when the plan of treatment was changed and when, in particular, transfusion was used frequently and chemotherapy was employed routinely. In 1947, at Grady hospital in Atlanta 62 cases of perforating rifle- and pistol-shot wounds were treated surgically with only 11 deaths, 17.7 per cent.²⁸ There seems to be no good reason why similar or better results should not become the rule.

CONCLUSION

The results achieved in abdominal injuries in World War II have never been surpassed in the history of surgery and have been equalled only in small series of selected cases treated by highly skilled surgeons. There is ample credit for all who participated in this achievement, but the young men who performed the bulk of the operations deserve the bulk of the credit. The skilful surgical technic and the brilliant surgical judgment exercised by them at the operating table established for all time the value of the residency system which had come to full flower between the wars. It was here that these young men demonstrated how well they had learned the lessons which they had been taught.

Gordon-Taylor,²¹ whose experience in World Wars I and II probably surpasses the military experience of any living surgeon, paid them a tribute with which I might well conclude this paper:

Ideals may be for pursuit and not for attainment, but he would be bold indeed who ventured to foretell that in this province of surgery the zenith of our achievement has yet been attained; already, indeed, the recovery-rate in the hands of a few individual surgeons, whom Luck has perhaps brushed with her wings, or who may have been blessed in the matter of environment or fortunate in other ways, has been of almost astronomical magnitude. There is much, therefore, to substantiate the claim of the young surgeon that in the treatment of abdominal casualties of war he has surpassed his teachers and the previous generation of war surgeons.

Macte virtute, puer, esto. Sic itur ad astra.

Well done, young man. That is the way to glory.

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DISCUSSION.—DR. PAT R. IMES, Louisville, Ky.: As Dr. Poer indicated, the greatest mortality factor in abdominal injuries in World War II was shock. Because of its importance and frequency in such injuries, the greatest benefit resulted from readily available whole blood which the Services provided for their care. I believe such availability of blood in civilian practice will show comparable improvement in the results. A review of the records of 53 patients admitted to the Louisville General Hospital because of abdominal trauma during 1946 showed that there were 15 deaths; two before surgery, five on the operating table and five within 24 hours following the operative procedure. I feel that these 12 of the 15 deaths might be attributed directly to the presence of shock. I also found that, in spite of our war experience, we were utilizing an average of 625 cc. of blood preoperatively and during the operative procedures, an obviously inadequate amount.

Regarding the policy of exteriorization of colonic wounds, there was not uniform agreement on this subject during the war. I did not feel that it should be practiced routinely and some of the British toward the end of the war likewise indicated their preference for primary closure in selected cases. On reviewing our experience in the Mediterranean theater, we were able to collect 168 cases who had primary suture of the colonic injury with a mortality rate of 24 per cent, which not only compared very