

Management of the Major Coagulopathy with Onset during Laparotomy

H. HARLAN STONE, M.D., PRISCILLA R. STROM, M.D., RICHARD J. MULLINS, M.D.

An experience with 31 patients who developed major bleeding diatheses during laparotomy was reviewed. Management of the initial 14 patients was by standard hematologic replacement, completion of all facets of operation, and then closure of the peritoneal cavity, usually with suction drainage; only one patient survived.

The subsequent 17 patients had laparotomy terminated as rapidly as possible to avoid additional bleeding. Major vessel injuries were repaired; ends of resected bowel were ligated; and holes in other gastrointestinal segments and the bladder were closed by purse-string sutures. One patient had a ureter ligated. Laparotomy pads (4-17) were then packed within the abdomen to effect tamponade, and the abdomen was closed under tension without drains or stomata. Following correction of the coagulopathy, the abdomen was re-explored at 15 to 69 hours in the 12 survivors. Definitive surgery then was completed: bowel resection and reanastomosis; ureter reimplantation; drains for bile, pancreatic juice, and urine; and stomata for bowel or urine diversion or decompression. Eleven of 17 patients, deemed to have a lethal coagulopathy, survived.

This technique of initial abortion of laparotomy, establishment of intra-abdominal pack tamponade, and then completion of the surgical procedure once coagulation has returned to an acceptable level has proven to be lifesaving in previously non-salvageable situations.

ONE OF THE MOST FRUSTRATING SITUATIONS ever encountered by the operating surgeon is an open wound in a patient whose blood will not clot and cannot be made to clot. By far the most extreme example is a bleeding diathesis complicating laparotomy. This event is an all-too-common occurrence in the patient who has sustained a major intraabdominal injury or who has a disease process or operation which has been attended by a massive hemorrhage. The coagulopathy can seldom be reversed satisfactorily. Thus, the usual outcome is continued bleeding and thereby death through exsanguination.

From the Department of Surgery, Emory University School of Medicine, Atlanta, Georgia

Throughout the centuries of recorded medicine, direct pressure has been the most reliable means of gaining immediate control of hemorrhage, regardless of the cause. The surgeon's finger, a pack, or some form of a pressure dressing are classic maneuvers. Successful application of such methods to the profusely bleeding liver wound logically suggested that the same principle might prove to be effective even when a bleeding diathesis had led to a relatively diffuse hemorrhage throughout the entire peritoneal cavity.^{1,2}

Immediate results from this approach were impressive. Accordingly, a comparison was made between results obtained in prior years by standard efforts at coagulopathy control in the patient with an open abdomen and what appeared to be a significantly improved outcome when some form of immediate abdominal tamponade had been invoked.

Patient Review

Between July 1, 1976, and June 30, 1982, a major coagulopathy developed during laparotomy in 31 patients on the Trauma Surgical Service at Grady Memorial Hospital. During the first three years of review, 14 patients were managed by standard procedures directed toward reversal of the bleeding diathesis plus completion of all details in the operative procedure. In the ensuing three years, once a coagulopathy was noted in the following 17 patients, operation was immediately aborted, abdominal tamponade was effected through packing and closure under tension, and later, reexploration was performed, once the patient's blood adequately clotted, to complete the initial operative procedure.

Patient ages ranged from 17 to 67 years, with an average of 28 years. There were 22 blacks and nine whites, 25 men and six women.

Presented at the Ninety-Fourth Annual Meeting of the Southern Surgical Association, December 6-8, 1982, Palm Beach, Florida.

Reprint requests: H. Harlan Stone, M.D., Department of Surgery, University of Maryland Hospital, 22 South Greene Street, Baltimore, Maryland 21201.

Submitted for publication: January 3, 1983.

Penetrating wounds were the indication for laparotomy in 24 patients (Table 1). Two had sustained blunt abdominal trauma. There was a total of 115 specific organ injuries, 32 being vascular, in these 26 patients. Some form of peritonitis was the indication for surgery in the remaining five patients.

Presence of a coagulopathy was first suggested by absence of observable clots in 25 patients, continued bleeding from the wound surfaces without an identifiable vessel injury in five patients, and, in the final patient—a report by the anesthesiologist of abnormalities in several of the clotting tests. Essentially all of the patients had a significantly prolonged clotting time if the blood did clot, as well as an abnormal prothrombin time and partial thromboplastin time (Table 2). In two patients, platelet counts were depressed below $10^5/\text{mm}^3$, but were still greater than $4 \times 10^4/\text{mm}^3$. Only one patient had an extreme deficit in fibrinogen, although two others had values less than 100 mg/dl.

No significant differences were noted between the treatment groups with respect to any of these detailed parameters.

Management

During the earlier years of patient review, all coagulopathies were managed by the administration of whole blood, to combat shock, plus fresh frozen plasma and platelet infusions. One patient required fibrinogen as well. Then, the surgical procedure was always completed—as long as the patient still lived—without any abbreviation of operative steps. After operation, repletion of clotting factors, *i.e.*, fresh frozen plasma and platelets, was continued as dictated by demonstrable deficiencies in the clotting mechanism.

The protocol for abdominal tamponade was as follows: immediate termination of the operation; repair of only those vessels vital to survival, with ligation of all others; ligation of bowel ends with a purse-string inversion as a second layer—somewhat similar to what is done for the appendiceal stump; and then purse-string closure of all bowel holes. The spleen and kidney, if bleeding, were removed unless renal injury was bilateral, for which the kidneys were packed. Ureteral wounds were managed by simple ligation, while the bladder was closed with a one-layered purse-string suture. If the pancreas had been resected, the stump was ligated with an umbilical tape. Gallbladder wounds were closed by a purse-string suture, yet major bile duct injuries were merely isolated by a laparotomy pack. There were no drains, and no bowel or urinary stomas were created. An average of nine laparotomy pads (range of 4–17) then were packed tightly into the peritoneal cavity, and the abdomen was closed under considerable tension with

TABLE 1. Major Coagulopathy during Laparotomy

Indications for Operation	No Pack	Packed
Penetrating trauma	11	13
Blunt trauma	1	1
Peritonitis		
Mesenteric thrombosis	—	1
Gangrenous obstruction	1	—
Perforated diverticulitis	—	1
Pancreatic abscess	1	1

a continuous suture for the peritoneum, one for all components of the muscle and fascia as a single layer and one for the skin.

Associated injuries were at times even more challenging, as tamponade of certain viscera precluded acceptable function for a given organ system. For example, the hemothorax could be controlled temporarily by clamping of the thoracostomy tube, yet the resultant lung compression uniformly led to restriction in the ventilatory capacity. As a result, intermittent decompression of the hemothorax proved to be the only practical answer. With increased intraabdominal pressure, there was forced elevation of the diaphragm which, of itself, further compromised ventilation. Some form of respiratory assistance with a positive airway pressure was needed almost routinely in these cases.

Other wounds were packed also and the skin was oversewn tightly. This method was used for simple lacerations as well as the more complicated open fracture. Nasal packing was required for two patients.

Intervening management was directed toward correction of the coagulopathy by repletion of clotting factors (*e.g.*, fresh frozen plasma and platelet infusions), hematologic checks on measurable steps in the clotting

TABLE 2. Coagulation Defects

	No Pack	Packed
Patients	14	17
Clotting time		
>20 minutes	14	17
Never clotted	13	15
Prothrombin time		
5 seconds > control	14	17
15 seconds > control	13	15
Partial thromboplastin time		
>40 seconds	14	17
>100 seconds	13	16
Platelet count		
<40,000/mm ³	13	16
<20,000/mm ³	10	15
Fibrinogen		
<100 mg/dl	2	2
<40 mg/dl	1	0

TABLE 3. *Complications in the Survivors (12 Packed; 1 Without Packing)*

Wound infection	12
Intraabdominal abscess	9
Acute respiratory distress syndrome	4
Pneumonia	5
Empyema	1
Pancreatic fistula	1
Intestinal fistula	2
Intestinal gangrene	1
Gastritis	2
Oliguric renal failure	5
Polyuric renal failure	4
Phlebitis	7
Miscellaneous	21

mechanism (*i.e.*, clotting, prothrombin, and partial thromboplastin times as well as platelet counts and fibrinogen determinations), and ventilatory assistance via a positive airway pressure, *e.g.*, constant positive airway pressure (C-PAP) and PEEP. Additional skin perforations were avoided whenever possible. Thus, an attempt was made to both monitor and infuse the patient through a single transvenous route.

Intraabdominal packs were left within the peritoneal cavity for 15 to 69 hours, with an average of 27 hours. The decision to reoperate was based entirely upon the observation that the patient's blood would now clot within a ten-minute interval. Specific measurements of various components of the clotting mechanism were used only as a guide to repletion, not as an indication of operability.³

At the delayed operation, all packs were removed, and then the necessary surgical procedures were performed on a patient who no longer had uncontrollable bleeding. Resected bowel was reanastomosed in three patients and managed by creation of an end stoma in seven patients. A decompressive gastrostomy and enterostomy were

performed in two patients with duodenal wounds. Six patients had a colostomy created. Suprapubic cystostomies were installed in two patients, and the ureter was reimplanted into the bladder in one of these patients. A cholecystectomy and distal pancreatectomy en bloc with splenectomy were carried out in one patient each. Abdominal drains were inserted in all cases.

Results

The bleeding diathesis was controlled in only two (14%) of the 14 patients managed by standard practices. Only one patient survived, attested by a mortality rate of 93%. However, when abdominal tamponade was used, the coagulopathy was corrected eventually in 14 (82%) of the 17 patients; 11 patients survived, thereby yielding a mortality rate of 35%.

Death was the result of exsanguination in 12 of the patients treated during the earlier years. The other fatality was in a patient with shock refractory to all measures. By contrast, when treated by abdominal packing, only one patient died of continued hemorrhage. Two deaths were due to refractory shock. One death was a result of anuric renal failure and two deaths were results of multiple problems without a single process appearing most responsible.

No patient was free of complications (Table 3). Wound infection occurred in all patients treated by packing, but did not develop in the surviving patients managed by repletion therapy alone. Intraabdominal abscess was another frequent complication. Pulmonary problems, oliguric and polyuric renal failure, pancreatic and intestinal fistulas, and pressure necrosis of a segment of bowel due to the tightly fitted pack were among the more major complications noted. Accordingly, such problems led to difficult later care as well as prolonged hospitalization.

There was no significant difference between the two treatment groups with respect to volume of blood and blood products used prior to the onset of coagulopathy (Table 4). However, far greater volumes of blood ($p < 0.001$), plasma ($p < 0.01$), red cell mass ($p < 0.001$), and platelets ($p < 0.02$) were required when abdominal packing had not been used.

Discussion

Packing of the wound, no matter how massive, has been found to provide at least partial arrest of hemorrhage in patients with an abnormal as well as a normal clotting mechanism.^{1,2} The abdominal cavity does not defy this principle. In fact, an inverse relationship has been demonstrated between rate of intraperitoneal hemorrhage from an arterial wound and tamponading intraabdominal pressure.⁴ Use of laparotomy pads, rather

TABLE 4. *Major Coagulopathy during Laparotomy*

	Volume (ml) of Blood Products Administered			
	No Pack		Packed	
	Average	Range	Average	Range
Prior				
Blood	7320	4400-9750	6896	4150-9500
Plasma	358	0-1250	320	0-1000
RBC	270	0-750	440	0-1500
Platelets	61	0-250	28	0-125
After onset				
Blood	21754	2000-35500	5287	2500-8500
Plasma	4978	2750-8250	2728	1750-4750
RBC	3872	1500-6500	746	0-2250
Platelets	2071	625-4875	1341	625-2375

than an added volume of shed blood and thus its complicating influence on an already established coagulopathy, seems to be a more reasonable approach. Results from this review support such a contention.

Timing of the delayed laparotomy must be based upon documentation of a once-again effective clotting mechanism. This decision for reoperation should be made upon observation that blood will actually clot, because a bleeding diathesis still may persist despite normal values for coagulation components. Contrariwise, although the same components may be deficient, blood may indeed clot.³

Because of problems with subsequent development of intestinal fistulas, it has been preferred at second laparotomy to oversee the distal bowel and to create an end stoma for the most proximal line of intestinal transection. Then, anastomosis can be done beyond that point, because protection has been afforded by complete intestinal diversion.

Likewise, because of the predictably high rate of wound infection, delayed primary closure of the skin and subcutaneous tissues is the better choice.

DISCUSSION

DR. JOSEPH S. MCLAUGHLIN (Baltimore, Maryland): Those of us who do thoracic and cardiac surgery have encountered this phenomenon on many occasions. One sees this following trauma, occasionally with pulmonary resections and most often following cardiopulmonary bypass. If one places pressure on the area which is bleeding, and maintains this pressure for a few minutes, the bleeding stops. The problem is that once pressure is released, in a few minutes the clots lyse and the bleeding once again becomes uncontrollable.

Most of us around the country have adopted a similar methodology to control this situation. Chest tubes are inserted in the usual manner, because we can't pack the pericardial sac, the incision is closed, and the patient is placed on PEEP. PEEP acts as an internal tamponade, increasing the pressure in the chest to the point where small capillary oozing stops. Fresh frozen plasma, platelets, and—at times—Amicar are administered to control the coagulopathy.

It occurred to me that in many of Dr. Stone's patients there were situations where no further operative procedure would necessarily need to be carried out. Further, many patients who come into our emergency rooms are treated by MAST trousers because of uncontrollable bleeding. These external trousers are placed on persons, especially those with pelvic fractures, and are highly effective in tamponading by external pressure. I wondered whether or not the same sort of system could be utilized in the patients that Dr. Stone described—

During the interval between aborted laparotomy and second exploration, significant increases in intraabdominal pressure due to packing create major difficulties with ventilation. Accordingly, a positive airway pressure must be maintained at times with an end-expiratory pressure often exceeding 30 cmH₂O. The latter routinely complicates venous return to the heart, and thus demands that both ventilatory as well as cardiac dynamics be monitored carefully.

References

1. Fabian TC, Stone HH. Arrest of severe liver hemorrhage by an omental pack. *South Med J* 1980; 73:1487-1490.
2. Feliciano DV, Mattox KL, Jordan GL Jr. Intra-abdominal packing for control of hepatic hemorrhage: a reappraisal. *J Trauma* 1981; 21:285-289.
3. Harrigan C, Lucas CE, Ledgerwood AM, Mammen EF. Primary hemostasis after massive transfusion for injury. *Am Surg* 1982; 48:393-396.
4. Richards AJ Jr, Lamis PA Jr, Rogers JT Jr, Bradham GB. Laceration of abdominal aorta and study of intact abdominal wall as tamponade: report of survival and literature review. *Ann Surg* 1966; 164:321-324.

specifically, those patients who do not require further operative procedures.

DR. PAUL H. JORDAN, JR. (Houston, Texas): Harlan, I presume that the cases you reoperated on did not have the coagulopathy again. All you did was give them platelets and fresh-frozen plasma.

The question I have is: What should we do to avoid getting into this situation in the first place? What is the key there?

DR. H. HARLAN STONE (Closing discussion): Insofar as the MAST trousers are concerned, they do offer another modality for controlling the hemorrhage. Nevertheless, we still would need to reoperate on the patient to remove clot, which otherwise would become infected. We have preferred to use the pack. It is not by any means new; it has been used for quite a long time. Several patients have been referred from other parts of Georgia, and one knew immediately that the referring surgeons were a bit worried because of the obvious packs protruding from the abdomen. MAST trousers might offer an alternative approach.

With respect to Dr. Jordan's question, how to avoid all of this, I really do not know the answer. There has been some attempt at legislation for gun control, but I believe that education of the population and the acquisition of more humane values are the only final solutions.