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THE AUTOMOTIVE SAFETY BELT: IN SAVING A LIFE MAY PRODUCE INTRA-ABDOMINAL INJURIES

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INTRODUCTION

The value of the safety belt in reducing the frequency and severity of injuries resulting from automobile accidents is well documented and accepted.[3, 7, 12, 15, 16] There have been suggestions however, that the safety belt possesses certain intrinsic hazards and may expose belt wearers to certain "other injuries," particularly in the abdominal region.[3] In spite of these warnings and the increasing use of safety belts, there have been only 10 recorded cases of intra-abdominal injuries caused by safety belts in the accident records kept by local and federal authorities, five in the American literature[5, 8, 9, 10, 14] and five in the foreign literature.[6, 16] This type of injury is rare, but is serious and at times life threatening.

The reported cases of intra-abdominal injuries resulting from wearing a lap-type safety belt are summarized in Table I. The structures injured included duodenum, pancreas, ribs, small bowel, spleen and gravid uterus. Although no fatality was recorded in this group, delay in diagnosis and treatment resulted in prolonged hospitalization and extended morbidity.

Intra-abdominal injuries resulting from the shoulder-type belt are summarized in Table II. The structures injured in this group were hepatic veins, kidneys, renal artery, spleen and liver. These injuries were more severe and resulted in considerable mortality in spite of early recognition and treatment.

The present report adds four patients to those in the literature and analyzes the diagnostic criteria and the manner in which the injuries occurred.

CASE REPORTS

Case 1. W. Mac is a 42-year-old white male who was driving his car at about 45 m.p.h. on an icy night, when he struck the rear of another car which had not started to move after the light changed. He had applied his brakes but was not able to stop, and the impact of the collision drove the other car 100 feet down the road. Although his car was badly smashed, he was able to unfasten his seat belt and get out of the car. When the police arrived some 20 minutes later, he noted the onset of rather acute lower abdominal pain which was interpreted by

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TABLE I

Intra-Abdominal Injury From Lap-Type Safety Belt

Author	Situation of Accident	Symptoms and Physical Findings	Timing of Operation after Injury	Pathology	Course
Garrett and Braunstein[8]	Male driver, age 32, crashed head on at 35 m.p.h.	Unknown	Unknown	Ruptured duodenum and pancreas	Prolonged hospitalization. Recovered.
Tolins[11]	Male driver, age unknown, hit post at 65 m.p.h.	Acute distress, ecchymosis from belt, generalized tenderness, WBC 11,700.	96 hours	2 cm. perforation—mesenteric border proximal jejunum	Complicated course. Discharged 64 days postinjury.
Cocke and Meyer[5]	Female passenger, age 64, crashed into side of car at 35 m.p.h.	Red from belt across upper abdomen, minimal left abdominal and shoulder pain.	5 hours	Shattered spleen, fractured ribs	Complicated course. Discharged 22 days postinjury.
Rubovits[10]	Female passenger, 6 months pregnant, car hit in right side at 35 m.p.h.	Red from belt across lower abdomen. "Slight" abdominal tenderness. Hb 13—7 gm.	48 hours	Partial avulsion lower uterus—6 cm. tear left uterine horn. Fetus free in abdomen.	Presumed satisfactory.
Kulowski and Rost[7]	34-year-old trooper hit truck broadside at 45 m.p.h.	Low abdominal spasm. Obstructive symptoms 4 months.	4 months	Distal ileum adherent to pelvic brim, complete obstruction.	Benign.

TABLE II

Injury From Shoulder-Type Safety Belt

Author	Situation of Accident	Symptoms and Physical Findings	Timing of Operation after Injury	Pathology	Course
Engberg[4]	Female in right front, age 40, hit by truck head-on at 45 m.p.h.	Pain and tenderness in epigastrium and over right chest.	1 hour	Hepatic veins torn from vena cava.	Died in shock at operation.
von Bahr and Eriksson[12]	Male driver age 39, hit from side.	Left chest pain, tender over fractured ribs.	None	Ruptured left kidney, left renal artery torn from aorta.	Cardiac arrest on way to O.R.
	Female in right front, age 17. Ran broadside into other car.	Comatose with facial lacerations and fractures.	None	Ruptured liver and spleen.	Transferred to another hospital D.O.A.
	Female in right front, age 20. Crashed head-on.	Abdominal distention and tenderness.	None	Ruptured right kidney (x-ray).	Recovered.
	Driver, age 33, hit head on at high speed.	Right chest pain and shock.	1 hour	Tear, right lobe of liver, fractured ribs on right.	Recovered.

the police as acute alcoholism in spite of his stating he had had but "one beer." He was brought to the hospital for a blood alcohol test by the police.

Physical examination revealed a well-developed white male in distress. His pulse rate was 88, respirations 20, and blood pressure 130 80. Although a faint smell of beer was detected on the patient's breath, it was clear he was not in-

ebriated. The positive physical findings were limited to his abdomen which was slightly protuberant, splinted, and showed no evidence of trauma. Cough tenderness was referred to just below and to the left of the umbilicus. There was guarding and splinting of the entire abdomen with maximum tenderness in the lower abdomen to the left of the midline. Bowel sounds were absent. Rectal examination was negative.

Exploratory laparotomy was carried out approximately three hours after the accident. Upon opening the peritoneal cavity through a right paramedian incision, a small amount of thin seropurulent material was noted and cultured. Loose early fibrous adhesions were encountered between loops of small bowel and the anterior abdominal wall in the left mid lower abdomen. A free perforation was discovered measuring 2 cm. in diameter on the antimesenteric border of the mid ileum. This was closed transversely. The remainder of the exploration was negative. The patient's postoperative course was uneventful. He was discharged on his seventh hospital day and recovery was complete.

Case 2. W. Z., a well-developed 33-year-old white female, was the passenger in the right front seat of the family car driven by her husband on September 27, 1964. She held her 13-month-old daughter in her lap with her 12-year-old son riding in the back seat of their 1959 four-door Chevrolet. They had just turned onto a main highway on a rainy overcast afternoon at about 20 m.p.h. when they were struck in the right front by an oncoming automobile traveling at a speed in excess of 50 m.p.h. This car caromed off the front of their car, spun 180 degrees, then struck them in the rear before it came to rest 100 feet down the road. The front end of the patient's car was totally demolished.

The patient's husband, uninjured, unfastened his seat belt, and pried his way out of the car. The patient, on the other hand, had considerable back pain and was not able to move until the ambulance arrived. She was transported by stretcher on her abdomen arriving at the hospital approximately 45 minutes after the injury

On admission, she complained of severe back pain and headache She was lying on her abdomen in acute distress. Her pulse rate was 92, respirations 18, and blood pressure 118/70. Her nose was deviated to the left, and a moderate amount of clotted blood was noted in her left nares. There was a moderate amount of swelling with marked tenderness over her mid back. She had contusions of her arms and legs. Her neurological examination was normal. X-rays showed a fracture of the lamina of the second lumbar vertebra. The abdomen revealed a contusion of the anterior abdominal wall extending from just above the right iliac crest transversely across the abdomen and across the left iliac crest. Bowel sounds were absent. Initial tenderness was minimal, but progressed over the next one and one-half hours to become generalized and most marked in the lower abdomen just to the left of the midline over the rectus sheath. Peritoneal taps which were initially negative were repeated. A faint trace of blood was aspirated from three quadrants, and two cubic centimeters of blood which did not clot were aspirated from the fourth quadrant (RUQ). Smear of the fluid revealed many leukocytes.

Laboratory studies revealed a hematocrit of 38, a white blood cell count of 17,600 and a normal urinalysis except for a few red blood cells per high power field.

Although the patient's vital signs remained unchanged, the changing abdominal findings and the positive peritoneal tap necessitated abdominal exploration. Five hours after admission, under general anesthesia, exploration through a left paramedian incision was undertaken. Upon opening the anterior rectus sheath, a large hematoma was encountered. As the rectus muscle was retracted laterally, it was discovered to be transected by the seat belt at the junction of its middle and lower thirds. The inferior epigastric vessels lay undisturbed hugging the posterior rectus sheath.

The peritoneal cavity was opened and a moderate amount of blood was encountered and cultured. The mid portion of the omentum had been amputated from its attachment to the transverse colon, and was hanging by only one thin vascular stalk. This stalk was ligated and the omentum removed. The liver, spleen, stomach, pancreas, gallbladder and duodenum were normal. The small bowel at approximately 18 inches from the ligament of Treitz revealed a 3-cm. hematoma in the mesentery contiguous with the bowel wall. Twelve inches further was another hematoma with a similar relationship to the intestine. The hematomas appeared stable and the bowel viable. At the level of the mid small bowel there was a five-inch perpendicular laceration in the mesentery. Small arcuate vessels were ligated and this tear was closed. Eighteen inches more distally another such laceration was found and treated similarly. The bowel in these areas was uncompromised. No further injury to the small bowel was found other than a moderate-sized (8 cm.) hematoma at the base of the mesentery, which was felt to be due to a fracture of the second lumbar vertebra. The right colon was contused in its mid portion with a 3-cm. vertical tear in the serosa. Upon mobilization, the colon was felt to be viable and was simply replaced and covered with the remaining right half of the omentum. When no further injury was found, the abdominal cavity was aspirated of remaining blood and closed. Reduction of the nasal fracture was accomplished before the patient was returned to the recovery room.

Postoperatively the patient was maintained on a Foster frame and made an uneventful recovery. On October 27, 1964, the patient had a Hibb's spinal fusion followed two weeks later by application of a body spica, and then discharged two months following her initial injury. She has now completely recovered.

Case 3. G. L., a 16-year-old white female, was the passenger in the right front seat of a Volkswagon about midnight, May 30, 1964, when the driver lost control of the car and it slid sideways into a fire plug which struck the car just below the driver's door. One-half hour after the accident, the patient arrived at the hospital complaining of severe back pain and with little recollection of the event.

Physical examination revealed a well-developed, well-nourished teenage white female in moderate to acute distress. Pulse rate was 100, blood pressure 108 74,

and respirations were 20. Positive physical findings were limited to her nose which was red, tender and swollen. There was a suprapubic abrasion conforming to the position of the seat belt. There was moderate spasm, rebound and tenderness in all quadrants. Bowel sounds were hypoactive. Abrasions were present on both knees. Neurological examination was normal. There was swelling and tenderness over the second lumbar vertebra. X-rays revealed a fracture of pedicles of the vertebra. Intravenous pyelogram was normal and her white blood cell count was 6,650.

Abdominal injury was suspected and the patient was observed. When repeated abdominal examination showed increasing tenderness, exploration was undertaken five hours after admission. There was a transverse tear at the junction of the second and third portions of the duodenum on the posterior and inferior aspect involving approximately two-thirds of the circumference, with a moderate amount of retroperitoneal contamination. No source of intraperitoneal bleeding was found. The pancreas was felt to be normal.

Postoperatively, she did fairly well but complained of left chest and left upper quadrant pain with slight tenderness. White blood cell count and amylase remained elevated for approximately one month. Spinal fusion was accomplished three weeks following her accident and was uncomplicated. Abdominal symptoms persisted for approximately one more month. She was placed in a body jacket on August 5, 1964, and discharged on August 7, 1964. Eventual recovery has been complete. A rhinoplasty and submucous resection were performed on February 3, 1965.

Case 4. R. N. is a 20-year-old white male who was a passenger in the left back seat of a 1963 Plymouth on the clear summer evening of August 14, 1965, when the car went out of control and struck a tree head-on at a speed in excess of 50 m.p.h. The driver and passenger in the front seat were able to unbuckle their seat belts and leave the car, having suffered only a few facial lacerations. The patient, complaining of hip pain, was brought to the hospital by ambulance arriving approximately one-half hour after the accident at 11 p.m.

The patient was found to be a well-developed 20-year-old white male with a blood pressure of 114/78 and a pulse rate of 80, in no apparent distress but complaining of hip and leg pain. The positive findings were limited to his abdomen where abrasions were found across his iliac crests and lower abdomen, conforming to the shape of the seat belt. There was slight tenderness over this area but no other tender areas. Bowel sounds were present. There was slight pain on flexion of the hips but no deformity or impairment of motion. Pelvic and hip films were negative. Neurological examination was negative. He was observed.

Over the next four hours, his bowel sounds decreased. There was slight left rectus spasm with a question of rebound tenderness. Over the next six hours the patient developed progressive lower abdominal rigidity, absent bowel sounds, bilateral shoulder pain and a white blood cell count of 16,400. Abdominal x-rays, a cystogram and peritoneal taps were all negative. Twelve hours after admission exploration was undertaken.

Through a left paramedian incision the abdomen was entered and bloody

fluid encountered. Exploration revealed a 6-cm. tear, with small bleeding arcuate vessels along its edge, in the mesentery of the mid ileum perpendicular to the normal appearing adjacent bowel. The vessels were ligated and the defect closed. A similar tear was found in the mesosigmoid. The sigmoid itself was contused, showed subserosal hemorrhage and was questionably viable. This segment was exteriorized as a loop colostomy. Further exploration was negative. The peritoneal cavity was aspirated of free blood and the wound closed.

The patient recovered without incident, the colostomy closed two weeks later, and he was discharged three and one-half weeks following his admission.

DISCUSSION

It is evident from the cases in this series and from those in the literature that early diagnosis and treatment are essential in the management of intra-abdominal safety belt injuries. Furthermore, it can be seen that diagnosis may be difficult because of associated injury or circumstances. Therefore, a review of the diagnostic criteria might be helpful.

Diagnosis. Because of the rarity of this injury, it is important to approach the accident victim who has been wearing a safety belt with a high index of suspicion that he might have an intra-abdominal injury.

Historical data regarding the circumstances of the accident should be obtained from the patient or ambulance personnel, including speed, direction of impact, condition of car, and how the seat belt was applied. The speed at impact was in excess of 35 m.p.h. in the majority of the cases and the impact was taken by the front of the car in 10 of the total 14 cases. The four vehicles in this series were all beyond repair. Although the safety belt was applied correctly in the present group of patients, Cocke and Meyer[3] reported a case of ruptured spleen and fractured ribs from a belt incorrectly placed across the upper abdomen.

Initial symptoms and physical findings were minimal. External evidence of trauma conforming to the configuration of the safety belt is helpful in suspecting intra-abdominal injury, but its presence or absence does not confirm or rule out intraperitoneal trauma. Case 1 in this series had no external evidence of trauma and yet the patient had a perforation of his ileum. Mention is made in the literature of 79 crash victims[2, 8] who sustained lower abdominal wall contusions from a safety belt, but were otherwise uninjured. The uninjured crash victims in our series all sustained lower abdominal contusions from their seat belts.

The changing clinical course with increasing abdominal tenderness and gradual loss of bowel sounds was confirmatory evidence that intraperitoneal injury had occurred. X-ray studies may be of value in the diagnosis of ruptured duodenum or gravid uterus. Peritoneal paracentesis should be used when the diagnosis is questionable, but a negative tap should not be interpreted as meaning intra-abdominal injury has not occurred. The finding of an elevated white blood cell count is helpful in suspecting intra-abdominal injury, but again is only suggestive.

Treatment. Treatment of the intra-abdominal injuries will be determined by the situation found at the time of exploration. Hemostasis should be achieved,

rents in the mesentery closed, nonviable small bowel resected, colon injuries exteriorized if viability is questionable, and other injuries treated appropriately.

Mechanism of Injury—Lap Belts. It is evident from these four cases and from those in the literature that the safety belt is capable of producing a wide variety of injuries. The mechanism of production of these injuries is summarized in Table III.

If the safety belt is worn properly by the accident victim and maintains its position in contact with the iliac spines, then a simple contusion by direct violence in this area might be expected. The belt that is improperly applied or fails to maintain its position, by torsion of the wearer, may produce further injury to the abdominal wall. The patient in Case 2 sustained such an injury. Although her belt maintained its position initially, when her son flew over the front seat on top of her, the belt slipped over her right iliac crest and, as her body twisted, sheared through her left rectus muscle. She might have been uninjured had her son in the back seat been wearing a safety belt.

When the braking force from the belt is applied suddenly to the abdominal wall, intra-abdominal viscera are prone to injury. Depending on the position or change in position of the belt, all abdominal organs could be traumatized. Prior to the adoption of seat belts, auto accident victims who sustained blunt adbominal trauma were prone to injure solid organs or a fixed hollow viscus. Although these structures may still be injured, they are not as liable to be injured as the small bowel and its mesentery.

Seat belt injury to the small bowel and its mesentery is produced by direct violence or by entrapment with subsequent perforation. The deceleration force is applied to the small bowel directly (Fig. 1A, frontispiece). The small vessels on the mesenteric border are torn resulting in a hematoma. If the force is great enough, the mesentery is torn perpendicular to the intestinal wall (Fig. 1B). If the hematoma is small, with few vessels torn, then the bowel will remain viable. On the other hand, if considerable devascularization has occurred with devitalization, then gangrene and perforation will occur. Cases 2 and 4 involved this type of injury. Tolins' case[14] demonstrates how perforation can occur in the area of a hematoma if the injury is extensive enough.

Bursting injuries to the small intestine which may result from a safety belt can be produced by direct violence or by entrapment depending on the condition of the underlying small bowel. The conditions necessary for this injury to occur were elucidated by Sauerbruch[11] and summarized in Table IV. Although direct violence by the safety belt to a distended loop or next to a distended loop may produce perforation, entrapment of a short segment of bowel with production of a closed loop obstruction and perforation may also occur (Fig. 2). Case 1 is an example of bursting injury due to entrapment since the small bowel was not distended at exploration. Kulowski and Rost's case[9] may have been this type of injury which sealed itself off and went on to eventual obstruction.

The colon is injured in the same way as the small intestine. The ascending colon in Case 2 was trapped against the posterior abdominal wall by the belt which resulted in a contusion, hematoma and serosal tear. It is conceivable that

TABLE III

Mechanism of Abdominal Injuries by a Safety Belt

1. Direct violence
2. Shearing or torsion
3. Entrapment
4. Combination of these factors

TABLE IV

Conditions Necessary for Bursting Injury of the Intestine

1. Marked distention of bowel
2. Closure of a loop of bowel on both sides
   (a) Kinking at two places
   (b) Kinking at one place and closure by trauma at a second place
   (c) Double acting trauma closing bowel in two places
3. Contusion of abdomen in region of distended loops

under these circumstances, a distended cecum could sustain a bursting injury if the ileocecal valve was competent. The sigmoid colon injury in Case 4 was due to direct violence.

Trauma to the duodenum and pancreas is an uncommon but serious injury which can result from a seat belt. The mechanism of production of this injury in Case 3 was severe flexion of the patient to the left at the time of deceleration with a resultant shearing force acting on the junction of the second and third portions of the duodenum. The ruptured duodenum and pancreas reported by Garrett and Braunstein[8] may have occurred in a similar fashion.

The unusual omental injury in Case 2 resulted from entrapment of the omentum by the belt. As the deceleration force continued and the patient flexed, the omentum was avulsed from its attachment to the transverse colon, the colon being held firmly by the gastrocolic ligament.

The splenic injury incurred by the patient reported by Cocke and Meyer[5] was the result of direct violence from the ill-placed safety belt. This injury should not occur from a properly applied belt.

Rupture of the gravid uterus is an uncommon injury. Rubovits' patient[10] sustained such an injury. The deceleration forces absorbed by the lower uterine segment produced a tear in the myomentum. The force was transmitted to the amnionic fluid, resulting in increased hydrostatic pressure and ejection of the fetus through the left uterine horn into the free peritoneal cavity. The problem of the advisability of using lap belts during late pregnancy remains unsolved. On the basis of this one case it would appear they are hazardous.

Although rupture of the urinary bladder by a safety belt has not been reported, it is entirely conceivable that if distended with urine the bladder could easily rupture through its dome or base.

Mechanism of Injury—Shoulder Belts. The mechanism of production of injuries from shoulder belts is similar to that of lap-type belts. It would appear, however, that torsional forces play a more prominent role in the production of

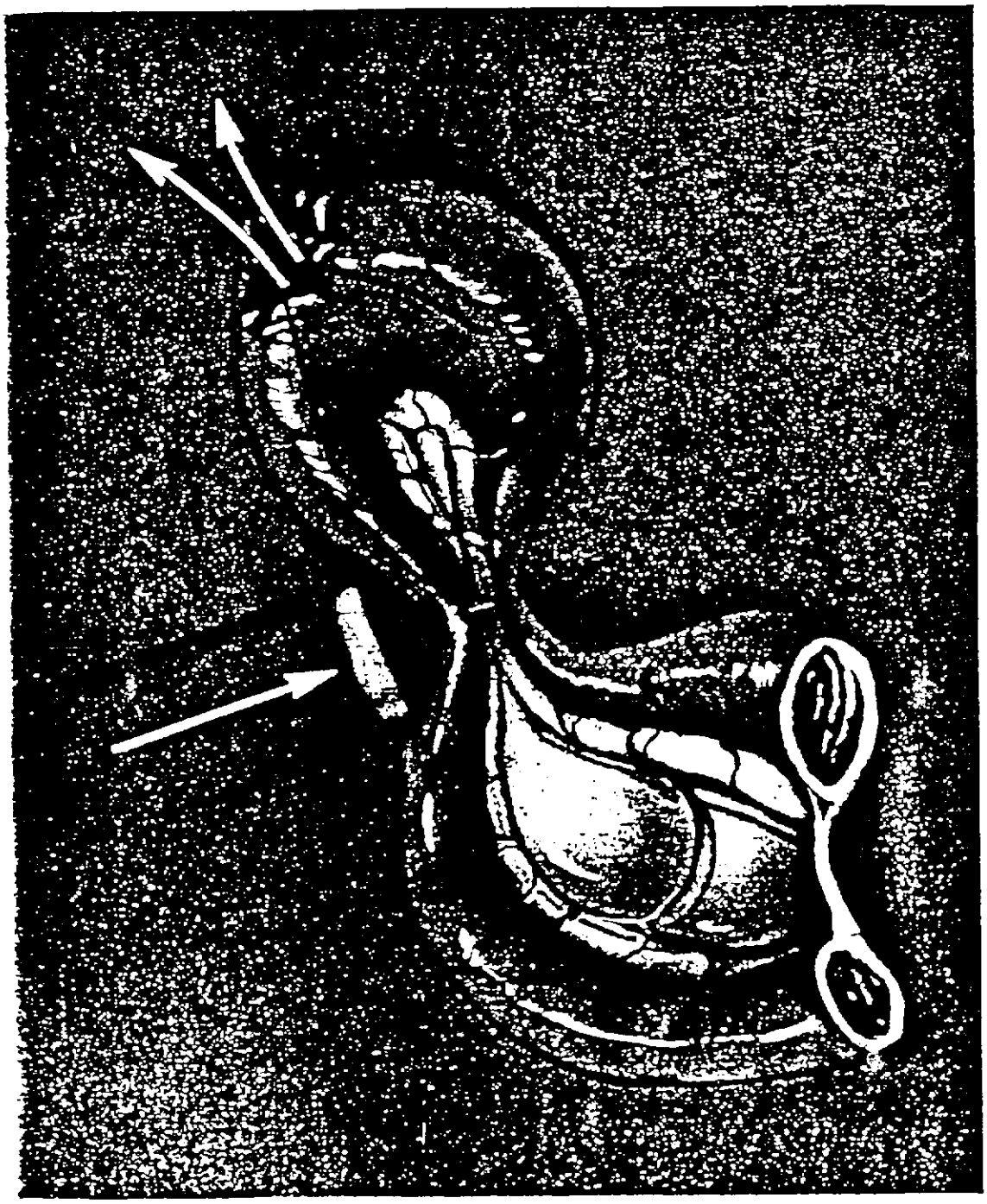

FIG. 2. Drawing of bursting injury to the small intestine.

shoulder strap trauma. As the victim's torso is twisted over the belt, ribs are broken, and the spleen, liver or kidneys themselves or their vascular attachments are prone to injury by this shearing force. It might be concluded from these few cases that the shoulder belt is capable of producing a more serious injury than the lap-type belt.

Safety Belt Modifications. Ejection of a crash victim at the time of, or subsequent to, impact is the leading cause of serious injury and mortality resulting from an automobile accident.[12, 15, 16] If an occupant is wearing a safety belt and should be involved in an accident, the risk of death or serious injury is 35 per cent less than for the occupant not using a belt.[16] On the basis of these statistically significant data and the rarity of intra-abdominal injury as a direct result of wearing a safety belt, it would seem ill advised to advocate abandonment of the safety belt.

The use of a shoulder belt in combination with a lap belt has been recommended[1, 4] and is in use. This combination still exposes the user to potential injury from torsional forces during an accident. These forces could be avoided by the use of a shoulder harness in combination with a lap belt. With this type of device the deceleration forces the wearer is able to withstand before injury are increased from 27 g. to greater than 46.2 g.[16] Although this is a substantially safer device, it is questionable whether or not it would be used because of the limitation of motion of the automobile occupant.

Perhaps the lap-type belt should be altered in such a way as to provide a certain amount of "give" with higher gravitational forces. This could be accomplished by interposing heavy coil springs between the belt and the chassis. Whether or not this would increase the deceleration limit is speculation, but it should be investigated.

CONCLUSIONS

1. Intra-abdominal injuries as a direct result of wearing a safety belt are rare with only 10 being reported in the literature. The four cases reported in this study bring the total number of known cases to 14.

2. In the previously reported cases the injuries were initially unsuspected, which led to delays in treatment with an associated high morbidity and mortality.

3. Evidence of external abdominal trauma which conforms to the shape of the safety belt is helpful in suspecting intra-abdominal injury, but its absence does not rule out intraperitoneal injury.

4. The diagnosis was made by evaluation of the historical facts regarding the crash, abdominal finding of pain and tenderness, diminished peristalsis, peritoneal paracentesis, and an otherwise unexplained white blood cell count, accompanied with a high index of suspicion.

5. Virtually all intra-abdominal viscera are prone to injury by the safety belt, but the small bowel and its mesentery appear to be most vulnerable.

6. The mechanism of production of injury is by direct violence, shearing or torsion, by entrapment or by a combination of these factors.

7. The use of a shoulder harness in conjunction with the lap belt might have prevented many of these injuries.

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ADDENDUM

Since presentation, two additional reports have appeared in the literature describing intra-abdominal injuries sustained by belt users. Fish and Wright (see following discussion) report four plane crash victims who sustained small intestine and mesenteric injuries, one of whom also suffered a ruptured spleen. (Fish, J. and Wright, R. H. The Seat Belt Syndrome—Does It Exist? J. Trauma, *5*:746–750, 1965.) Gerritsen, et al., describe two patients who were wearing automotive lap safety belts at the time of accident and sustained abdominal wall contusions, and injury to the small bowel and its mesentery. (Gerritsen, R., Frobese,

A. S., and Pezzi, P. J. Unusual Abdominal Injuries Due to Seat Belts. J. Einstein Med. Cent., *14*:63–66, 1966.)

DISCUSSION

DR. JAY C. FISH [Galveston, Texas]: Our experience with the "seat belt syndrome," as we have called it, will appear in the *Journal of Trauma* soon. This concerns four patients who were involved in an Army "Caribou" crash shortly after takeoff. There were 25 people in the airplane, 18 of whom were passengers. They were lined up facing the center line of the plane, and were wearing lap-type seat belts, with their right sides to the front of the plane. Four men had a belt-like mark of contusion across the lower abdomen. Two of them presented as acute emergencies and were operated upon. Both had avulsion type injuries of the mesentery in which a segment of the bowel was ripped loose from its mesenteric attachments. The principal problem in these patients was hemorrhage and shock. One patient was successfully treated and one died prior to reaching the hospital.

The other two with subacute injuries were operated upon eight and nine days later, respectively, and both recovered. These two patients had perforations of the distal ileum and presented with vague, nondescript complaints that initially were attributed to contusion of the abdominal wall.

We are now aware of the fifth case seen by one of our residents at another hospital. This patient was in the subacute category, with perforation of the ileum.

We believe these cases constitute enough basis to postulate a "seat belt syndrome" which can be divided into two categories. The first is the acute syndrome in which hemorrhage from mesenteric tears is the major factor, and the second is a delayed reaction from perforation of the ileum.

DR. MACDONALD WOOD [Phoenix, Arizona]: I rise to defend the seat belt. I think we all recognize the value of the seat belt, and the discussion today is pertinent to the injuries as a result of it.

I have had experience with only one case of seat belt injury, involving a young man who was sleeping in the back of his car with his seat belt loosely attached. As a result of the impact he was thrown forward and suffered a compression fracture of two lumbar vertebrae in addition to evulsion of the mesentery and small bowel of the ileum. The latter was not recognized until two weeks after the injury. The ileus, as a result of the fracture, was interpreted as retroperitoneal hematoma before surgical consultation was obtained. A fatal peritonitis with abscess developed.

I congratulate Dr. Williams for bringing up this mechanism of injury. However, in prevention I think we should point out that the belt should not be worn during pregnancy.

DR. PAUL W. BRAUNSTEIN [Bay Shore, New York]: I would like to make just one point. In the auto crash studies for Cornell we studied thousands of people involved in accidents, and we found no increase in intra-abdominal injury. I think that is a very important point to make.

We also have studied some cases in New York. The police told us how bad the belt was because one policeman was strangled with a belt. Very obviously it was inadequately applied. The belt should not contact the abdominal viscera; it is a restraining device on the bony pelvis. If the belt causes a flank contusion or abdominal contusion, it has been improperly applied. It is the most important safety device we have. I appreciate the injuries that occur, but still say that the seat belt is the only device we have as yet developed which has really helped decrease serious injuries.

DR. HORACE HERBSMAN [Brooklyn, New York]: I rise to bring attention to one other fact.

One patient whom I saw recently, a 55-year-old woman, was riding in the right front seat of an automobile with a seat belt in place, when the car was involved in an accident with another car at an intersection. She was brought to the Kings County Hospital in shock. Abdominal paracentesis was positive for blood and a transverse seat belt bruise on her lower abdomen was noted. She was taken immediately to the operating room after attempts at resuscitation with large amounts of blood and colloid. During exploration, cardiac arrest occurred and she died. Her findings are of interest:

The bruise was across her lower abdomen. It seemed to be right at the upper portion of the iliac crest. She was very obese and a good portion of her abdominal wall probably fell over the belt. An avulsed small bowel mesentery was found at surgery, with a large amount of blood in the peritoneal cavity. The entire root of the mesentery had been torn off, except for the superior mesenteric artery, which was bleeding from a tear in its wall.

The conclusion we draw is not that the seat belts are outmoded, but that seat belts should be modified to a wider width for obese people so that this band-like shearing force across the lower abdomen would not occur in these cases.

DR. JAMES S. WILLIAMS [Rochester, New York]: I thank the discussants for their comments. I would like to point out intra-abdominal injuries caused by safety belts are very rare. We certainly hope that our presentation will not be misconstrued to mean that we are advocating the abandonment of safety belts. We are not. The safety belt prevents ejection and, therefore, prevents a great many serious and mortal injuries. We only stress that, if early diagnosis is to be made and treatment undertaken, one has to approach an accident victim who has been wearing a seat belt with a great deal of suspicion that he may have an injury somewhere in his abdomen. Delays in treatment lead to a high morbidity and mortality.

In regard to Dr. Braunstein's comments, proper application of the belt is very important. If the belt is not properly applied, in contact with the iliac spines, it certainly does predispose the wearer to other serious injury.