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## Abdominal Trauma from Seat Belts

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THE USE of the lap type automobile safety belt can result in abdominal injuries to automobile accident victims.<sup>3, 4, 5, 6, 7, 8, 9, 10</sup> These injuries may be related to improper application of the seat belt. As in many abdominal injuries due to blunt trauma, the initial evaluation of the victim may be misleading. The following eight cases illustrate the characteristic findings, associated injuries, and treatment.

### Case Reports

*Case 1.* A 31-year-old woman was admitted to the hospital on December 31, 1965, one hour following an automobile accident. The patient was thought to be the least injured of five persons involved in the accident. At the time of the accident, she had been riding in the right front seat with a lap seat belt loosely fastened across her abdomen.

On physical examination the abdomen showed an ecchymotic area just below the umbilicus. Bowel sounds were heard. Mild diffuse abdominal tenderness to palpation was observed. The hematocrit was 42 per cent, blood leukocyte count 14,800 with 88 per cent polymorphonu-

clear leukocytes. Urinalysis was normal. Abdominal and upright chest films were normal.

Due to signs of progressive peritonitis and the appearance of a tender fluctuant mass in the cul-de-sac, a laparotomy was performed 6 hours following injury. A two centimeter perforation was found on the mesenteric border of the jejunum 16 centimeters from the ligament of Treitz. There were copious amounts of bowel contents throughout the abdominal cavity, which proved to be sterile on culture. The laceration was closed following debridement of the edges of the wound. Except for prolonged ileus, the postoperative course was uneventful.

*Case 2.* A 36-year-old man was the driver of a car involved in a two-car accident. His seat belt was loosely fastened around his upper abdomen.

Two hours after the accident, cursory physical examination at the hospital was negative. The patient was sent to the waiting room while more seriously injured patients were attended. Thirty minutes later, he complained of severe abdominal pain. Physical examination at this time revealed normal vital signs. There was an ecchymotic area over the lower abdomen. Bowel sounds were absent and there was minimal tenderness, rigidity, and rebound over the entire abdomen.

Hemogram and urinalysis were normal.

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Chest roentgenograms, supine and upright abdominal roentgenograms and intravenous pyelogram were normal. A four-quadrant abdominal paracentesis was non-revealing.

Over a 3-hour observation period, the patient's abdominal symptoms became worse and his temperature increased to 38°C.

At operation, 7 hours after the accident, the only abnormal finding was a 1.5 centimeter perforation on the antimesenteric border of the small bowel in the region of the jejuno-ileal junction. Only a small amount of bowel content was present in the abdominal cavity, cultures of which were negative. The edges of the torn bowel were excised and the perforation was closed. The postoperative course was uncomplicated.

*Case 3.* A 34-year-old woman was involved in a head-on collision on March 27, 1966. She was a passenger in the right front seat of the automobile with a lap type seat belt applied loosely over the anterior superior iliac spine. At the time of impact, her head hit the dash board and she was unconscious until she arrived at the hospital.

On physical examination at the hospital, there was a severe nasal and maxillary fracture. A linear contusion approximately five centimeters in width extended across the abdomen at the level of the infra-umbilical area. There was tenderness with muscle spasm and rebound in this area. Laparotomy was performed 3 hours post-admission. Approximately 400 cc's of blood was found in the peritoneal cavity. The ileum along a distance of approximately 10 centimeters was torn from the mesentery. This area was resected and primary anastomosis performed. The patient's postoperative course was entirely benign.

*Case 4.* A 12-year-old girl, daughter of patient 3, was admitted to the hospital after the same accident. She had been semi-recumbent in the back seat with her seat belt fastened loosely over the upper abdomen.

On physical examination, pulse was 120 per minute, blood pressure 130/70. She had a linear abrasion similar to her mother's which was located in the epigastrium. The abdomen was board-like with diffuse generalized and rebound tenderness. There was a tenderness over the mid-lumbar spinal area. Roentgenograms demonstrated a fracture dislocation of #2 and #3 lumbar vertebrae.

Within an hour after admission, the patient underwent a laparotomy. Three perforations of the small bowel within 2 feet of the ligament

of Treitz were noted. The bowel at the area of one of the perforations was separated from its mesentery and was not viable. This was resected and a primary anastomosis performed. The other two perforations were closed after debridement. Four lacerations of the root of the mesentery were noted and repaired. The omentum was partially avulsed from the transverse colon parts of which were removed.

Postoperatively, she was kept in hyperextension because of the fracture dislocation of L 2-3. The dislocation did not reduce spontaneously and on her third postoperative day open reduction and spinal fusion was performed. Following the second operation, recovery was uneventful.

*Case 5.* A 58-year-old physician was admitted to the hospital on July 15, 1967, shortly after a head-on collision. The patient had been riding in the back seat of a station wagon with the lap belt fastened firmly over the iliac spine.

Blood pressure was 90/60, pulse was 120 per minute. There was an obvious dislocation of the right shoulder. A transverse ecchymotic area was present across the lower abdomen. There was diffuse tenderness, greatest in the left upper and left lower quadrant with marked rebound tenderness and muscle spasm. Bowel sounds were hypoactive.

After infusion of one unit of dextran and one unit of whole blood, vital signs returned to normal. At laparotomy, approximately one liter of blood was found in the peritoneal cavity which had come from four longitudinal tears in the rear of the mesentery. There was a perforation in the distal jejunum and the distal sigmoid colon had been completely denuded of its seromuscular coat. Over an area of approximately 10 centimeters, multiple small tears of the serosa of the sigmoid colon and its mesentery were noted. The mesenteric lacerations were closed and the sigmoid colon resected. A single-barreled proximal colostomy was performed with closure of the rectal sigmoid segment. The dislocation of the right shoulder was reduced.

Postoperative course was remarkably benign and the patient was discharged from the hospital on July 28, 1967. He returned to the hospital on August 28 for removal of the sigmoid colostomy and reanastomosis.

*Case 6.* A 57-year-old woman, wife of patient 5, had been riding next to her husband in the back seat of the station wagon involved in the accident.

On physical examination at the hospital, she

did not appear to be severely injured. There was diffuse mild tenderness over the abdomen and a linear abrasion from the seat belt extending across the abdomen and the infra-umbilical area. Bowel sounds were present; no muscle spasms were noted. There was a comminuted, displaced fracture of the left olecranon process. Vital signs were stable. The patient was observed for approximately 4 hours, after which time abdominal rebound tenderness and muscle spasm developed.

A laparotomy was performed. A one centimeter perforation of the antimesenteric border of the proximal jejunum was noted which was closed. Two very small serosal tears of the sigmoid colon were also repaired with single 000 silk sutures.

The patient recovered uneventfully. On the thirteenth postoperative day, the olecranon fragment was excised and she was discharged.

*Case 7.* A 35-year-old woman was admitted to the hospital on August 10, 1964, following an automobile head-on collision into an overturned truck. She was transported from the mountains, where the accident occurred, in an ambulance and had received plasma intravenously enroute. The patient was approximately 5 months pregnant.

Physical examination revealed the abdomen to be moderately distended; the uterus was palpable one half way between the symphysis and umbilicus. Bowel sounds were absent. The blood pressure and peripheral pulse both were unobtainable. There was blood in the vagina. An abdominal paracentesis was positive for blood. At laparotomy the uterus was found to be extensively lacerated and a fetus was free in the abdominal cavity. A sub-total hysterectomy and left salpingo-oophorectomy was performed. The left retroperitoneal hematoma was drained. The fetus weighed 264 grams. During the procedure, the patient received 11 units of whole blood. After operation, blood pressure was 120/90 with a pulse of 100 per minute.

Postoperatively, the patient was confused and disoriented for a period of 5 days. A left, third nerve palsy was noted on the first postoperative day. On the second postoperative day, bilateral carotid arteriograms were performed. No abnormalities were noted. At this point, the patient was also found to have a fractured scapula which needed no therapy. Convalescence was slow, but marked by gradual improvement. She was discharged on the 26th hospital day in good condition. During the hospital course, she received 14 units of whole blood, three of which were

given within 48 hours postoperatively. The other units were given during operation.

*Case 8.* A 38-year-old man was admitted to the hospital on July 26, 1966, after an accident had caused his car to spin off the road. The patient was the only one in the car who had a seat belt fastened. Upon arrival at the hospital, blood pressure was 40/0 with a pulse of 120 per minute. He had an obvious fracture of the nose. A contusion across the lower mid abdomen with skin abrasion was noted with ecchymosis, and a rather large area of ecchymosis of the right lateral abdomen and superior iliac regions posteriorly was found. Bowel sounds were absent. A board-like rigidity of the abdomen was noted with some fullness. A severely comminuted compound fracture of the middle and lower third of the left leg was sustained with maceration of muscle, artery and veins. Abdominal exploration revealed two traumatic tears in the terminal ileum, the more distal of these was seven centimeters from the ileo-colic junction. In addition, the bowel was completely separated from the mesentery in several areas which were bleeding. The terminal ileum and cecum with the appendix was excised and an ileo-descending colostomy was performed. A below-the-knee amputation of the left leg was performed. A total of four units of whole blood were given before and during operation.

The patient's postoperative course was stormy, marked by fever and abdominal distention. On the fifth postoperative day the fever rose to 40°C (R) and a fluctuant right lower quadrant mass was noted which was incised and drained of purulent material. The flank subsequently drained fecal material and an ileo-cutaneous fistula developed. Barium enema demonstrated the fistula opening to be 18 centimeters proximal to the anastomosis. On the twenty-seventh postoperative day a laparotomy was again performed. A large traumatic lumbar hernia with incarceration and strangulation of the ileum was found. The necrotic ileum was resected and the lumbar hernia was repaired. Following this operation the patient recovered rapidly and was discharged from the hospital 14 days later.

### Discussion

Extensive research has been done with dummies in simulated automobile crashes using a lap belt as the sole restraining device.<sup>6</sup> At the time of impact, the body moves forward 6 inches or more depending on slack of

the seat belt. The belt then forcibly restrains the pelvis and the upper torso jackknives over the belt compressing the lumbar vertebrae. The abdominal viscera are first subjected to abrupt deceleration and then to possible compression. Injuries to the lumbar vertebrae were reported in two of the cases of Williams, *et al.*<sup>10</sup> and noted in two of our patients.

Williams *et al.*<sup>11</sup> reported that intestinal and mesenteric injury secondary to blunt trauma was most frequently caused by crushing against the spine rather than bursting of a closed loop as previously reported. The injuries described are believed to be due to the crushing mechanism because the intestinal perforations have been found in the mid-jejunum overlying the spine. When a seat belt is fastened over the pelvis, the pelvic bones absorb the blow rather than the abdomen and intestinal tract. In Cases 1, 2, 3, 4, and possibly 8, the belts were loosely or incorrectly applied. It is possible, however, for injury to occur with proper application of the belt because of severe forward flexion. It is difficult to keep the belt in its proper position with passengers who are pregnant although we believe the increased risk of its use would be diminished by the addition of a shoulder strap.

A consistent finding in our patients has been a contusion extending across the abdomen in the shape of the belt. This must be considered an ominous sign and an indication for laparotomy when associated with even the least sign of visceral injury. As stated, the surgeon must not ignore the possibility of serious spinal injury.

One of the solutions to this problem, of course, is to prevent forward flexion of the upper torso by a shoulder strap.<sup>2</sup> The use of the lap belt alone prevents ejection from the car during an accident, but for those not ejected the frequency of injury is generally the same for those using lap belts as compared to those who did not. This is not to condemn the lap belt, since the prevention of ejection significantly lowers the fatality and major injury rate. It has been widely stated that routine use of the lap belts could save 5,000 lives yearly.<sup>1</sup> Addition of the shoulder strap would substantially improve the figure in our opinion.

### Summary

Eight cases of abdominal injury due to the use of the lap type of automobile safety belt are reported. A contusion in the shape of the belt was noted on the abdominal skin of most of the patients. This is an ominous sign. If the lap type belt alone is used, its correct application across the bony pelvic ring is important. As in other forms of blunt abdominal trauma, careful and prolonged evaluation is necessary with early laparotomy, if indicated. The association of lumbar spine injuries is stressed. The use of the shoulder strap in conjunction with the lap belt substantially reduces the frequency of abdominal injuries.

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