Isolated traumatic supradiaphragmatic transection of the inferior vena cava associated with seat belt and airbag use in motor vehicle crashes

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Central Message

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In motor vehicle crashes, seat belt injuries mainly comprise various abdominal injuries,¹ which are decreased by the use of advanced airbags in combination with seat belts.^{2,3} However, improvement of seat belts and airbags may not protect passengers from strong deceleration injuries to the cardiovascular structures in the hard-shell thoracic cage. We describe 2 cases in which drivers were protected from motor vehicle crashes by a lap-diagonal seat belt and airbags but experienced an isolated traumatic transection of the inferior vena cava (IVC).

CASE DESCRIPTION

In June 2017, a 45-year-old man with no remarkable medical history was in a motor vehicle collision and had chest tightness. Upon arrival to the emergency department, he became drowsy. His blood pressure was 70/50 mm Hg

FIGURE 1. Enhanced CT scans. A, Short-axis view shows a large hemopericardium (white arrow). B, Sagittal view shows dye extravasation around the IVC (white arrow). C and D, A 1-inch long, 26-mm graft was interposed to connect the right atrium and IVC.

FIGURE 2. A, Follow-up enhanced CT scan at postoperative week 3. B, Venogram at 70 months postoperatively. Both images reveal a patent supradiaphragmatic interposed graft (white arrows) between the right atrium and the IVC. L, Liver.

and was quickly restored after transfusion. Full-body enhanced computed tomography (CT) scanning revealed a large hemopericardium and contrast leakage from the supradiaphragmatic IVC, without injuries to the other organs or structures (Figure 1, A and B).

Through an exploratory median sternotomy, a pericardial hematoma was removed, and bleeding from the injured IVC was confirmed. The heart was in place. After systemic heparinization, emergency cardiopulmonary bypass was established via the right femoral artery and vein. Another venous cannula was placed in the superior vena cava. After cardioplegic arrest, it was clear that the patient exhibited complete transection of the IVC along the upper diaphragmatic plane, without other cardiovascular injuries.

A linear tear from the severed plane of the IVC to the hepatic vein aperture was repaired from the inside using a continuous 6-0 polypropylene suture. To obtain a sufficient suture margin of the IVC, the IVC stump was dissected from the adjacent diaphragmatic hiatus. Direct anastomosis of the right atrial opening and the IVC stump made the suture line tense; therefore, a 1-inch long, 26-mm artificial graft was interposed between 2 separate structures using continuous 4-0 polypropylene sutures (Figure 1, C and D). The patient recovered well, and postoperative venography showed a proper diameter of the interposed graft.

In January 2009, a 42-year-old woman was in a car collision accident. Upon transfer to our emergency department, she was drowsy. Her blood pressure was 80/55 mm Hg, which was soon recovered with volume replacement. Non-enhanced CT scans from the previous hospital revealed a large hemopericardium without injuries to other organs. IVC injury was confirmed via median sternotomy. All procedures were the same as in the previously described case, except for interposition of a 2.0-cm long, 22-mm artificial graft. The patient recovered well. At postoperative week 3, enhanced CT scans revealed a patent IVC (Figure 2, A). At 70 months postoperatively, follow-up venography confirmed a proper IVC diameter (Figure 2, B), and

pressure tracing using a catheter revealed no pressure differential across the graft.

COMMENT

In motor vehicle crashes, the double safety provided by airbags and lap-diagonal seat belts has reduced the incidence of various injuries to the abdominal organs and spines.^{2,3} However, these safety features do not seem to protect the cardiovascular structures contained in the hard-shell thoracic cage. Within the hard-shell thoracic cage, the floating heart may be distorted and twisted against the IVC fixed to the diaphragm. Because of low-pressure bleeding from the vena cava, the hemodynamic instability caused by cardiac tamponade is generally not severe and is well tolerated with transfusion until establishment of cardiopulmonary bypass.⁴

The 2 presently described cases exhibited only complete transection of the IVC, without even 1 rib fracture. To reconnect the severed structures, interposition of a short artificial graft was a good option that guaranteed long-term patency without a pressure gradient. Cardiopulmonary bypass is useful to promote stable hemodynamics during surgery, sufficient space for anastomosis, and reduced blood loss.

CONCLUSIONS

The isolated supradiaphragmatic IVC transection is a specific type of a deceleration injury that may occur in drivers who are protected by a seat belt and airbags during motor vehicle crashes.

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