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Lessons Learned in Multicavity Polytrauma Management

AUTHORS:
Mubang RN; Smith MC; Guillamondegui OD; Dennis BM

CORRESPONDING AUTHOR:
Ronnie Mubang, MD
Department of Surgery, Division of Trauma and Surgical Critical Care
Vanderbilt University Medical Center
404 Medical Arts Building
1211 21st Avenue South
Nashville, TN, 37212
Email: ronnie.mubang@vumc.org

AUTHOR AFFILIATION:
Division of Trauma and Surgical Critical Care
Vanderbilt University Medical Center
Nashville, TN 37201

Background	We report a complex polytrauma case of a 45-year-old male involved in a motor vehicle collision that required a tremendous convergence of resources, with simultaneous operations performed by multiple teams, at an urban Level I trauma center.
Summary	The patient is a 45-year-old male involved in a motor vehicle collision. The patient was hypotensive at the scene and was given one unit of packed red blood cells by EMS en route. Upon arrival in the emergency department, the patient was normotensive. CT scans suggested a cardiac injury with hemopericardium, a right diaphragm injury, a grade V liver injury with active extravasation, a grade V splenic injury with active extravasation, and mesenteric hematomas with extravasation, along with concern for a left internal iliac artery injury. In the operating room, we performed a median sternotomy and exploratory laparotomy simultaneously. A complex left atrial injury was repaired at sternotomy via cardiopulmonary bypass. At laparotomy, a splenectomy, liver, and pelvic packing were performed in a damage control fashion. The patient was subsequently taken to interventional radiology for angioembolization of the pelvis and hepatic arteries with an open abdomen. Post embolization, the patient returned to the operating room for small bowel anastomosis and closure. He was in the hospital for 12 days before being discharged to rehab.
Conclusion	With the increasing complexity of polytrauma, management consistently necessitates the coalescence of resources and, in this case, simultaneous operations performed by multiple surgical teams.
Key Words	complex; polytrauma; cardiac; hemorrhage; damage control; open abdomen

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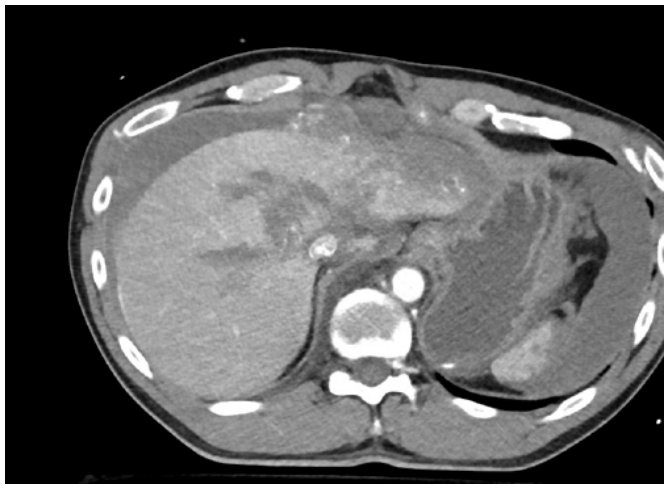
Case Description

The patient is a 45-year-old male that was a restrained driver involved in a motor vehicle collision with airbag deployment, requiring 30 minutes of extrication. Upon EMS arrival, he was alert, with a Glasgow Coma Scale (GCS) of 15. He was hypotensive but responded to one unit of packed red blood cells. The patient arrived at the trauma bay as a Level I alert. His vital signs were normal, and his GCS was 15. He was fully exposed and had no gross deformities. His chest X ray showed a widened mediastinum without a hemo- or pneumothorax. The trachea was midline, and the focused abdominal sonogram for trauma was positive for hemopericardium and hemoperitoneum. His pelvic X ray was unremarkable.

The secondary survey revealed abdominal tenderness and a notable seatbelt sign across both the anterior and superior iliac spine. Given the patient's hemodynamic stability, he was then taken for computed tomography (CT) scans of the head and cervical spine as well as the abdomen, chest, and pelvis with intravenous contrast. The CT of the head and C-spine were unremarkable. The CT scan of the chest, abdomen, and pelvis was significant for hemopericardium suggesting cardiac injury, right diaphragmatic injury, possible retrohepatic inferior vena cava injury, grade V liver injury with active extravasation, grade V splenic injury with active extravasation, mesenteric hematomas, and right internal iliac artery injury with active extravasation (Figure 1). The patient remained normotensive through his CAT scans. We ordered one unit of O-positive uncrossed matched trauma blood; however, he became hypotensive while taking the patient off the CAT scan table, and a massive transfusion protocol was activated.

The patient was taken to the operating room with an ongoing massive transfusion protocol; he responded appropriately. We briefly discussed with our anesthesia colleagues the plan to prep, drape, and prepare for incision before induction, following 1:1:1 packed red blood cells to plasma to platelet transfusion goals, respectively. We also placed a right femoral arterial line under ultrasound guidance. Anesthesia placed an ultrasound-guided right internal jugular cordis. He also had two 16 gauge peripheral intravenous lines. The patient was induced with ketamine and rocuronium using weight-based dosing. He remained normotensive throughout the induction phase. Operative planning was difficult, as, based on the imaging, the patient had lethal injuries in two cavities. Should we start with a median sternotomy or a laparotomy? We decided to begin with the median sternotomy to relieve tamponade. Later, we were joined by our cardiothoracic surgery colleagues, who began to assess and address the patient's cardiac injury, which was a large injury to the left atrium. Then, the decision was made by our cardiac surgeons to place the patient on the cardiopulmonary bypass to visualize and repair the left atrial appendage rupture accurately. This was performed with central cannulations using the right atrium and the aorta.

Figure 1. Axial Abdominal/Pelvic CT Showing Grade V Liver Injury with Active Blush. Published with Permission



We simultaneously proceeded with an exploratory laparotomy, splenectomy, liver packing, and suprarenal inferior vena cava repair, along with small bowel resection and oversewing of bleeding mesenteric vessels. The cardiac surgeons gave the patient a bolus of heparin before the bypass to fix the cardiac injury. Due to significant abdominal bleeding, we quickly packed all four quadrants in a damage-control fashion. A temporary abdominal closure was performed while the cardiac surgeons closed the sternum and three chest tubes, leaving the skin open after addressing the cardiac injury and getting off bypass. The patient was taken to the interventional radiology suite, where his right hepatic, left phrenic, and right internal iliac arteries were treated with angioembolization. We measured serial blood gases throughout his operative phase, including lactates, coagulation profiles (also TEGs), and temperature. He was then taken to the intensive care unit for ongoing resuscitation. He received a total of five coolers of MTP for the entire resuscitation. A cooler contains six packed red blood cells, four plasmas, and one six-packed pooled platelets, equating to 55 units of blood products. The following day, the patient was sent back to the operating room for small

bowel anastomosis and closure. The patient was extubated on postoperative day 3, had a persistent ileus until postoperative day 7, and was subsequently discharged to inpatient rehabilitation on postoperative day 11.

Discussion

Trauma is one of the leading causes of death among patients under 45 in the United States, trailing only heart disease, cancer, stroke, and chronic respiratory diseases.[1] Each year, more than 2.8 million patients are hospitalized due to injury,[2] with motor vehicle collisions accounting for the majority of those deaths.[3] Further, there has been an increase in polytrauma incidents.[4] Polytrauma refers to severely injured trauma patients with two or more injuries with a total Injury Severity Score (ISS) above 15 or an Abbreviated Injury Severity Scale (AIS) greater than 2 in at least two body regions.[4-6] Patients who suffer polytrauma require a more resource-intensive hospital course along with higher hospital costs.[6]

According to the Centers for Disease Control and Prevention, there has been a 25% decrease in deaths among severely injured trauma patients when these patients are cared for at a Level I trauma center compared to non-trauma centers.[3] Due to an increase in the complexities of such polytrauma, it has become necessary to quickly mobilize teams and resources to care for these patients. For patients with thoracoabdominal trauma, there is potential for concomitant injuries in two body cavities that create challenges in diagnosing and managing these patients.[8] Furthermore, clinical urgency due to hemodynamic instability may limit cavitary triage, thus increasing the complexity of their management.[9] Identifying the organ or cavity with the most urgent or severe injury for patients requiring surgery is ideal for preventing management delays and decreasing morbidity and mortality.

There is a paucity of literature concerning indications and practical application of simultaneous operations in the adult civilian trauma sector. Reports of simultaneous operations currently focus on extreme situations, such as severe traumatic brain injuries and abdominal injuries. However, data does exist that simultaneous operations can help reduce total operative time in complex polytrauma patients.[10] Typically, in civilian trauma sectors, one body cavity is prioritized over another. Previous data support laparotomy over thoracotomy when faced with diagnostic dilemmas in a hemodynamically unstable patient.[11] In our case, we obtained CT imaging, which helped us triage and prioritize our management algorithm. Though we were able to explore both cavities simultaneously, our first step was to decompress the tamponade via a median sternotomy. Our case demonstrates the feasibility and potential benefits of simultaneous operations on a patient at a Level I civilian trauma institution.

In recognizing the possibility of an injury that might require a cardiopulmonary bypass, we were able to mobilize a cardiac surgery team. We performed a median sternotomy and decompressed the tamponade, revealing a left atrial injury that could be temporized with a clamp but required complex repair. While the cardiac team proceeded with cardiopulmonary bypass and repair of the atrial injury, we were able to pursue hemostasis in the abdomen. By gaining some abdominal hemorrhage control with the splenectomy and small bowel resection, we could pursue angioembolization of both the hepatic and pelvic injuries. This shows the true capability of a Level I trauma center, having multiple resources available and multiple teams collaborating at a high level.

According to Strasser et al., simultaneous operations involve not only the surgeons but also the medical infrastructure (i.e., the anesthesia team, OR team, etc.). As such, the need for dual concurrent operations must be recognized early and implemented promptly.[12] During our case, we recognized the patient's needs with a CT scan and were able to arrange for such an operative pursuit. Patient positioning is also critical in these cases to allow both operating teams to identify and treat various pathologies properly. These complex cases create complicated logistics, which require systematic training of operating room staff to prevent demand problems.

The availability of interventional radiology cannot be overstated. This enabled the patient to be transported from the operating room to the interventional suite upon completion of the operation. In turn, having hybrid rooms (or rooms with both IR and OR capacities) is most appealing, as it prevents the need to transport the patient to another procedure room.

Conclusion

This report underscores the importance of specialized trauma care centers, collaborative approaches to managing polytrauma patients, and the need for advanced medical infrastructure and logistics to address the complex challenges posed by trauma cases in the United States. Polytrauma

cases, characterized by multiple severe injuries, are rising and pose challenges regarding resource allocation and hospital costs. Managing polytrauma patients, particularly those with thoracoabdominal injuries, requires coordinated efforts to identify and address urgent injuries. Simultaneous operations involving multiple surgical teams are proposed to reduce operative time in complex polytrauma cases. Collaboration, logistical preparedness, and the availability of interventional radiology are vital components in optimizing trauma patient outcomes.

Lessons Learned

When it comes to indications and coordination of simultaneous operations, there are no published guidelines. We must be cognizant of such limitations and implement various protocols and guidelines in our trauma centers to improve the care of our complex polytrauma patients, with the flexibility to adapt quickly to address the immediate situation.

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