Tourniquets, vascular shunts, and endovascular technologies: Esoteric or essential? A report from the 2011 AAST Military Liaison Panel

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As part of the 2011 American Association for the Surgery of Trauma (AAST) meeting in Chicago, the Military Liaison Committee led an interactive, case-based debate of vascular trauma and hemorrhage control entitled *Tourniquets, Vascular Shunts and Endovascular Technologies: Esoteric or Essential?* During the panel session, use of a real-time audience response system resulted in a sensing session during-which opinions and practice patterns related to these topics were tabulated. The purpose of this report is to provide the results from the audience response system gathered during this session as well as select peer-reviewed publications cited during the presentation of each scenario. In addition, the objective of this summary is to provide a perspective as to whether these surgical adjuncts or techniques are esoteric or essential in contemporary trauma practice.

SCENARIO 1 (TOURNIQUETS AND SHUNTS)

The first case from the panel focused on a patient with-gunshot wound to the thigh with hemorrhage at the scene. The audience was queried as to whether they thought that civilian first responders should be equipped with tourniquets to apply to this injury in the field setting. Of 158 respondents, 137 (87%) indicated that prehospital personnel should have tourniquets to use in this scenario reflecting an awareness of recently published work demonstrating the safety and efficacy of this adjunct.[1] Paradoxically, only 35% of the respondents indicated that prehospital personnel were equipped with this adjunct for control of hemorrhage.

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In this scenario, a tourniquet was applied, and the patient was transported to the nearest facility 35 minutes after the shooting. The patient remained awake with a systolic blood pressure of 110 mm Hg and a heart rate of 110 beats per minute. The on-call surgeon had an available operating room in the hospital, which was in the suburbs and 90 minutes by ambulance to a Level I trauma center. When asked for the best course of action, 82 (58%) of 142 respondents indicated that the patient should be taken to the operating room at the initial facility for tourniquet removal, injury exploration, placement of vascular shunt(s), and transfer (with the shunt[s]in place) to the Level I trauma center (Fig. 1).

When asked if there was utility in attempting to restore reperfusion at the earliest time point improves recovery.[2] This response is supported by a published research demonstrating the importance of early restoration of perfusion to an extremity after vascular injury and ischemia, especially in scenarios with concomitant hemorrhagic shock.[2] In an acknowledgment of recent reports showing the utility of temporary vascular shunts in the civilian and military setting, only 4% of AAST respondents answered that shunts rarely work and should not be tried by inexperienced surgeons.[3,4]

SCENARIO 2 (PELVIC FRACTURE AND SHOCK)

The second scenario involved a patient in a motor vehicle crash transported to a Level I trauma center where he arrived awake complaining of pelvic pain. The patient had a blood systolic blood pressure of 95 mm Hg and a heart rate of 110 beats per minute. The film of the pelvis showed a significant fracture, and the Focused Assessment with Sonography for Trauma (FAST) examination demonstrated a small amount of intraperitoneal fluid. There were no other injuries identified. When asked for the next step in the management of this patient, 125 (82%) of 152 respondents indicated placement of a binder or sheet around the patient's pelvic fracture. In this scenario, the patient was intubated because of shock, confusion, and pain and remained poorly responsive after transfusion of 3 U each of blood and plasma use despite the sheet wrapped tightly around the pelvis. The response of participants to the question of the next step in management is shown in Figure 2 with the most common choices being computed tomographic (CT) imaging and treating the patient with either coil embolization or preperitoneal packing. This response

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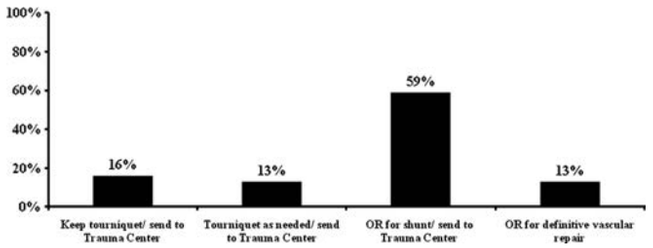

Figure 1. The audience response to a question regarding the best course of action in a scenario involving a patient with a gunshot wound to the lower extremity with hemorrhage and effective application of a tourniquet at the scene.

reflected an understanding of recent reports showing the effectiveness of a multimodality approach to the unstable pelvic fracture and shock.[5,6]

Only 5% of the 152 respondents to this question indicated that endovascular balloon occlusion of the terminal aorta as reported by Martinelli et al.[7] was a viable resuscitative option in this scenario; however, 74% of the respondents indicated that this maneuver had either been used at their facility or would be feasible and potentially beneficial if the technology improved (Fig. 3).

The patient in this scenario went to the operating room for preperitoneal packing without exploratory laparotomy, resuscitation, and placement of an external fixator device. The repeated FAST showed the same amount of fluid in the abdomen, and this patient then underwent a CT scan that 2 showed no solid organ injury but confirmed the pelvic fracture with a blush from a branch of the right internal iliac artery. This patient was then moved to the interventional suite where selective embolization of internal iliac artery branch was performed. When asked about the logistic aspects of care for this common injury pattern, only 15 (11%) of 138 respondents indicated that it was acceptable to have this patient managed in four different rooms (trauma room, operating room, CT scanner, and interventional suite) to diagnose and manage the injury. In contrast, 97 (70%) of the 138 members answering the survey indicated that the logistic course for this patient was a reality of the existing practice and imaging paradigm but likely to change in the near future.

SCENARIO 3 (BLUNT AORTIC INJURY IN DEPLOYED SETTING)

The next scenario presented was that of a US serviceman injured in Afghanistan in a motor vehicle crash resulting

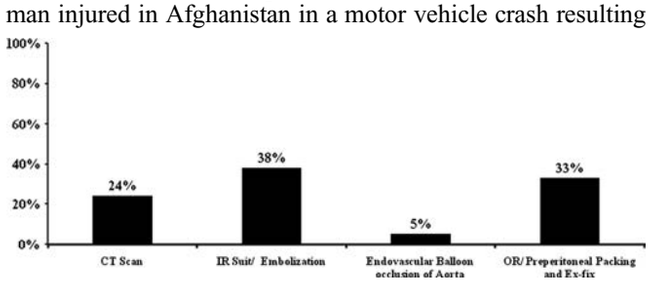

Figure 2. The audience response to a question regarding the best diagnostic and treatment maneuvers in a scenario involving a hypotensive patient with a severe pelvic fracture after a motor vehicle crash.

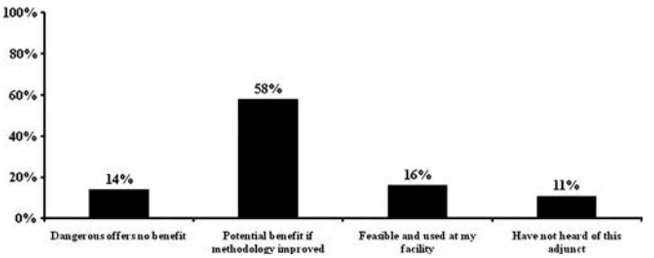

Figure 3. The audience response to a question regarding the feasibility and effectiveness of endovascular terminal aortic balloon occlusion as a hemorrhage control and resuscitation maneuver in the setting of severe pelvic fracture.

from a roadside bomb. This patient was unconscious and intubated and found to have a grade III liver injury requiring damage control laparotomy and packing. The patient had a femur fracture treated with an external fixator device and minor closed head injury managed with placement of an intracranial pressure monitor. The patient was also found to have a blunt descending thoracic aortic injury with a moderate-size hematoma around the aorta and a small left plural effusion. The audience responses to the question regarding the best course of management for this patient's aortic injury are shown in Figure 4.

Acknowledging recent reports on the changing management strategies for blunt descending thoracic aortic injury, most of the respondents advocated for endovascular stent graft repair of the aorta if the capability existed in-theater.[8] In a follow-up question, nearly two thirds of AAST members (82 of 131, 62%) favored the presence of an endovascular inventory and skill set in the deployed setting at level III surgical facilities, a capability that has been established at the Air Force Theater Hospitals during the wars in Afghanistan and Iraq (Fig. 5).[9,10]

SCENARIO 4 (RESUSCITATION FROM END STAGE SHOCK)

The final scenario was that of a male having sustained a gunshot wound to the left upper quadrant. The patient was unconscious and in shock en route and intubated. Upon arrival at a Level I trauma center, the patient had a systolic blood pressure of 75 mm Hg, a heart rate of 125 beats per minute, and a FAST examination which showed hemoperitoneum. This patient had a successful placement of large intravenous lines and a femoral arterial line and began receiving blood and plasma in the trauma room. Placement of a left tube thoracostomy resulted in the return of 400 mL of blood. After 10 minutes in the trauma room and performance of initial maneuvers, the patient was described as a transient responder with a second set of vital signs revealing a blood pressure of 90 mm Hg and a heart rate of 115 beats per minute. The audience response to the question regarding the best course of management for this patient is shown in Figure 6.

In agreement with the viewpoint of 134 respondents, this patient received judicious amounts of blood and plasma and went to the operating room for exploratory laparotomy. Upon preparation and induction, the patient lost vital signs and underwent anterolateral thoracotomy with cross clamping of the

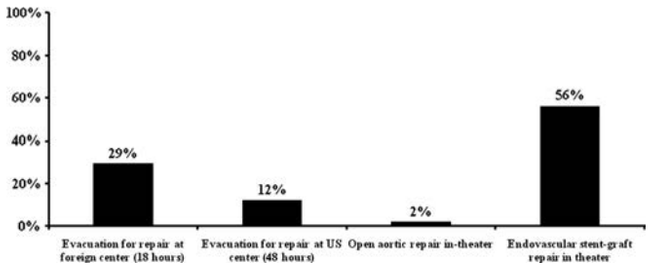

Figure 4. The audience response to a question regarding the best course of action for a US serviceman injured in the deployed setting. The injury in this scenario was a descending thoracic aortic injury after a motor vehicle crash resulting from roadside bomb.

descending thoracic aorta followed by a laparotomy, splenectomy, and repair of the diaphragm. When asked for the best course of action in transient responders with noncompressible hemorrhage and shock, 89% (119 of 134) of the audience favored the practice of permissive hypotension with judicious use of blood and plasma. Only 7% indicated that the recently reappraised technique of resuscitative endovascular balloon occlusion of the aorta was a viable option in this setting; however, like endovascular balloon occlusion of the terminal aorta for pelvic fracture and shock, nearly three quarters (100 of 134) of AAST respondents indicated that this maneuver had either been used at their facility or would be potentially beneficial if the technology and methodology improved.[11–14]

DISCUSSION

The interactive audience response system at the military panel provided excellent insight into the viewpoints of the AAST membership on the topics of hemorrhage control and vascular injury.[14] Although not validated, this method had a robust response ranging from 134 to 152 members throughout each of four clinical scenarios. One question designed to assess the genuineness of responses (Fig. 6) found unanimous selection of either the well-accepted course or other viable options with no respondents selecting the nonsensical choice.

On the topic of tourniquets, audience members and panelists identified a disparity between the recommendations for tourniquet use and the actual distribution or equipping of civilian personnel with these devices. The audience response confirmed the importance of expedited reperfusion of the extremity after vascular injury with ischemia including recognition of the utility of temporary shunts to accomplish this maneuver. The audience

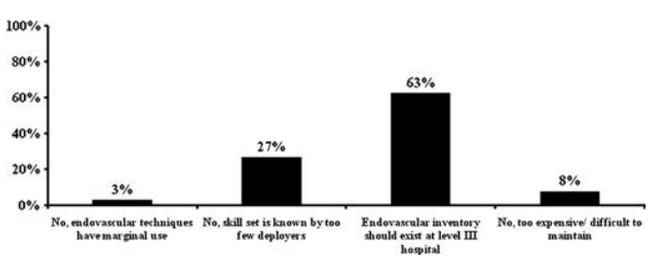

Figure 5. The audience responses pertaining to the need for or utility of an endovascular inventory and skill set in the deployed setting at level III surgical facilities.

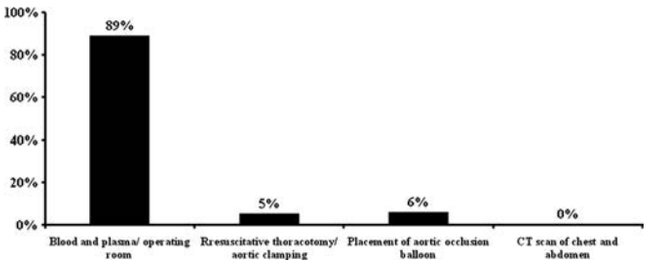

Figure 6. The audience response to a question regarding the best course of management for a patient in end class III or IV hemorrhagic shock after a gunshot wound to the left upper quadrant.

also identified a deficit in the integration of modern trauma and resuscitation practices and the requirement for multimodality imaging techniques. On this topic, there was consensus that the current paradigm that often resembles a maze of diagnostic and therapeutic maneuvers in multiple locations throughout the hospital needed to change. Members expressed the desire for a single, trauma resuscitation and operating room equipped with the capability to perform a full range of diagnostic and therapeutic imaging including CT scan and fluoroscopy (i.e., angiography).

In regard to endovascular technologies, there was recognition of their value in the management of certain patterns of trauma as well as their utility at higher echelons of care in the deployed setting. Respondents and panel members also acknowledged the potential benefit for resuscitative endovascular balloon occlusion of the aorta in scenarios of hemorrhagic shock. On this topic, members expressed that improvements in balloon device technology would be required for the technique to be used more frequently. Finally, audience members and panelists discussed a need within the trauma and acute care operation community to engage training opportunities for basic endovascular skills to use these catheter-based techniques. Collectively, the response from the AAST membership indicated that tourniquets, shunts, and endovascular techniques are not esoteric in today's practice. Rather, they are essential or emerging tools for hemorrhage control and the management of vascular injury.

DISCLOSURE

The viewpoints expressed in this article are those of the authors and do not reflect the official position of the United States Air Force or Department of Defense.

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