Are hybrid operating rooms the best place for vascular trauma management and the role of multimodality imaging?

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Trauma is a worldwide health problem that affects most people in some way during their lifetime. It accounts for about eight percent of the overall global mortality[1] and is the most common cause of death for those aged 1 to 45 years in the United States.[2] In the case of severe vascular injuries, the prevalence is approximately 6% of the overall civilian trauma population,[3] as well as one-fourth of patients with severe trauma to the abdomen.[4] Serious vascular injuries of the limbs are much more infrequent, affecting <1% of trauma patients.[5]

Because the temporal aspect is paramount in severe trauma cases, ad hoc diagnostic and treatment protocols have been developed, with several imaging methods used either as standalone modalities or in combination.[5] However, the availability of preoperative and intraoperative imaging methods of varying complexity, such as plain radiographs, ultrasound, computed tomography (CT) scans, digital subtraction angiography, and imaging fusion, varies between hospitals.

The aim of this editorial was to provide an overview on the central role of multimodal imaging modalities and hybrid operating rooms when dealing with vascular trauma.

Great advancements in trauma care have been made during the last half century. In the late 1970s, the Advanced Trauma Life Support[6,7] course, a systematic approach to the care of trauma patients, was initiated. The use of imaging techniques as adjuncts was also introduced, including radiographs in the emergency room to identify life-threatening injuries in need of urgent treatment quickly. The introduction of the easily accessible Focused Assessment With Sonography in Trauma (FAST) has further improved diagnostics.[8] FAST focuses on finding free fluid in the abdomen and the pericardium, and the extended version (e-FAST) also assesses the lungs for pneumothorax or hemothorax. The limitations include a low sensitivity, mainly because it is highly user dependent as well as being harder to interpret in obese patients. Therefore, a CT scan is the preferred diagnostic tool for trauma patients,[9-11] available in most trauma receiving hospitals in Europe or the United States (Fig 1). Whole body CT scans in arterial and venous phase (CT angiography) provides additional information and is recommended in the current guidelines for vascular trauma.[3,5]

Hybrid operating rooms represent a further development in optimizing care in vascular trauma. Current guidelines from the American Association for the Surgery of Trauma and the World Society of Emergency Surgery[3] recommend open surgery as the gold standard for the unstable bleeding trauma patient. Although trauma surgery in extremely unstable patients with, for example, clamping of the aorta or packing of the abdomen and pelvis can be performed without any preoperative imaging, the possibility of intraoperative imaging in a hybrid operating room, with the option to proceed with additional endovascular treatment, is preferrable.

The modern hybrid operating room is equipped with advanced medical imaging devices such as fixed C-arms and/or imaging scanners (Fig 2). Access to an accurate imaging modality in the operating room aids in identifying the most serious traumatic lesions to prioritize.[12-14] Hybrid operating rooms with access to fluoroscopy also allow for endovascular bleeding control with balloons and stent grafts, avoiding the need for extensive exposure in challenging anatomical situations. Moreover, hybrid and endosolutions open the door to more selective minimally invasive treatments such as embolization or restoration of arterial flow with endovascular techniques, either as standalone treatment or as a complement to surgical reconstructions. The use of multiplanar imaging can support the surgeon during the management of vascular trauma by guiding the intervention based on CT imaging acquired either preoperatively or intraoperatively. Intraoperative 3D fusion CT imaging during endovascular treatment of complex procedures has significantly decreased radiation exposure, procedure time and contrast usage, which may also decrease the overall physiologic impact of the repair.[14]

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Fig 1. Computed tomography (CT) scanner near the trauma room.

Fig 2. Hybrid room at the Uppsala University Hospital. Zero gravity: suspended radiation protection system (Biotronik Inc., Lake Oswego, OR).

In the light of this discussion, the hybrid operating room present itself as an appealing first choice in the management of trauma patients, in particular in cases with suspected vascular injuries. For countries and trauma centers with a low rate of seriously injured patients, there might be a high threshold to establish a

hybrid operating room for this sole purpose. Nevertheless, because hybrid operating rooms are becoming more common with the evolution of elective endovascular interventions, it is likely that we will see increased access to these rooms for trauma patients in the coming years. A study that evaluates hybrid operating rooms for trauma patients suggests several improved outcomes,[12] including lower mortality owing to exsanguination. However, overall mortality was similar to that of patients treated in conventional operating rooms.[12] Also, procedural time was shorter in the hybrid operating room group, although this difference diminished when the transport time to angiographic intervention for patients in the regular operating room was excluded.[12] Similar results have been reported when comparing outcomes for trauma patients before and after the introduction of a designated hybrid operating room, including a reduction in the need for blood transfusions (both red cells and plasma) and a shortening of the time to bleeding control.[13]

CONCLUSIONS

Multimodal imaging is paramount when dealing with vascular injuries. Hybrid operating rooms offer the option for acute open surgery, combined with advanced imaging techniques for the diagnosis and/or minimally invasive treatment of severe bleeding in cases of vascular injuries. However, the optimal use of the advanced multimodality imaging technologies available in modern hybrid operating rooms requires a high level of diagnostic and treatment expertise for all disciplines involved in the management of vascular trauma. Ultimately, the complexity of the lesions, the patients' general conditions as well as the local variability in access to advanced multimodal imaging should be taken into account when choosing between hybrid and conventional operating rooms. Multimodality imaging is likely to shorten treatment times and improve outcomes in critical trauma patients. Further evidence is, however, needed to establish the role of hybrid operating rooms as standard for trauma centers dealing with vascular injuries.

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