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REBOA as a bridge to brain CT in a patient with concomitant brain herniation and haemorrhagic shock - A case report

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ABSTRACT

Introduction: The management of complex trauma patient with concomitant brain injury and extra-cranial lesions is challenging since the requirement of a low pressure to limit the bleeding clashes with the need to maintain an adequate cerebral perfusion and to obtain a brain CT-scan. Here we present the use of REBOA as a bridge to CT scan in complex head and torso trauma.

Case presentation: A 59 years old male patient involved in a road traffic crash was admitted to our hospital after a car accident. He had a GCS of 3 with a left fixed pupil anisocoria. Despite right-sided chest decompression for pneumothorax and massive transfusion protocol for haemoperitoneum, blood pressure remained low; to temporally stabilize the patient and perform a brain CT scan a zone 1 REBOA was inserted and systolic blood pressure rose up from 60 mmHg to 110 mmHg. A brain CT scan highlighted a right subdural hematoma with a 8-mm midline shift. The patient went to the operating room to perform damage control surgery and, subsequently, a decompressive craniotomy. After 96 days of hospital stay, the patient was discharged at home with a complete neurological recovery.

Conclusions: The achievement of a rapid brain CT scan in traumatic brain injury is often crucial and has a deep impact in changing surgical management; moreover, duration of cerebral herniation is associated with worse outcome and increased mortality.

In the light of this, the use of REBOA in selected cases of complex head and torso trauma could allow to gain time to go to the CT room in safe conditions.

Background

Uncontrolled haemorrhage is the principal cause of death among trauma patients [1] and traumatic brain injury (TBI) is the leading cause of delayed mortality and disability [2]. Therefore the management of complex trauma with concomitant brain injury and extra-cranial lesions is a challenging situation associated with a high mortality rate.

In accordance with a recently published statement about the management of such a complex patient we have to face a major problem [3]: damage-controlled resuscitation with permissive hypotension to reduce further haemorrhage and coagulopathy with the concomitant need of maintaining a cerebral perfusion pressure to prevent secondary brain damage with a chosen systolic blood

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pressure (SBP) of 100 mmHg [4]. Moreover, in the management of a haemorrhagic trauma patient, the first thing to do is to stop the bleeding regardless of the presence of a non-haemorrhagic treat that could lead to severe disability and delayed mortality. In this kind of patient is often not possible (and it is not recommended) [5] to obtain a Whole-Body CT-scan (WBCT) even if it has been shown that integration of a CT scan significantly increases the probability of survival of haemorrhagic unstable patients with blunt trauma [6]. The reasons are both clinical (reduce the time to treatment) and non-clinical (CT room's distance from the shock room) [7].

Hybrid operative rooms, despite they are not present in every hospital, may represent a valuable solution to manage contemporary torso and head injuries after a rapid WBCT [8].

Although damage control surgery (DCS) is the cornerstone of the treatment of haemorrhagic torso injury and is feasible without a CT scan, the management of a herniating brain with a decompressive craniotomy requires a brain CT scan.

Our hospital hosts a well-established trauma pathway composed by: a shock room where a primary survey is performed and life treating injuries are managed (airway management, chest decompression, resuscitative thoracotomy), a near-dedicated CT room that allows the execution of a fast WBCT with CT angiography and an emergency hybrid operative room where it is possible to perform DCS (operative and non-operative management).

We now present a case of a patient with concomitant TBI with incipient brain herniation and haemorrhagic shock in which we used a resuscitative endovascular balloon occlusion of the Aorta (REBOA) to stop the bleeding and perform a focused brain CT scan before going to the hybrid operative room for the DCS.

Case presentation

A 59 years old male patient involved in a road traffic crash was admitted to our shock room. The trachea was intubated on the field due to a GCS of 3 and the patient was mechanically ventilated. A left-side out-of-hospital chest decompression was performed. SpO2 at the shock room entering was 80% in 1 FiO2. SBP was 60 mmHg. A left fixed pupil anisocoria was observed. The primary survey highlighted a right pneumothorax and a haemoperitoneum. A new right-sided chest decompression was performed with the restoration of normoxia. Hypotension remained unchanged despite massive transfusion protocol.

The trauma team decided to perform an emergent laparotomy and to temporarily stabilize the patient and perform an ongoing brain CT scan a zone 1 REBOA was inserted (Fig. 1). After the positioning SBP rose up to 110 with a MAP of 80 mmHg. A rapid brain CT scan was performed and highlighted a right subdural hematoma with midline shift >8 mm (Fig. 2). No others problems in patient management have been reported in the CT room.

Thereafter the patient went to the operating room. A DCS was performed with splenectomy and peritoneal packing. The total ischemia time was 30 min. Subsequently, a decompressive craniotomy was performed.

The overall patient's Injury Severity Score was 66. The total time spent in hospital was 96 days. By the time of the discharge, the patient had a complete neurological recovery.

Conclusions

We think that this case management could be a valid approach in the management of concomitant haemorrhagic shock and incipient cerebral herniation.

The optimum management is represented by a full hybrid shock room that allows the execution of both WBCT scan and surgical intervention. Kinoshita et al. reported that the use of a hybrid emergency room is associated with a decreased 28-days mortality in

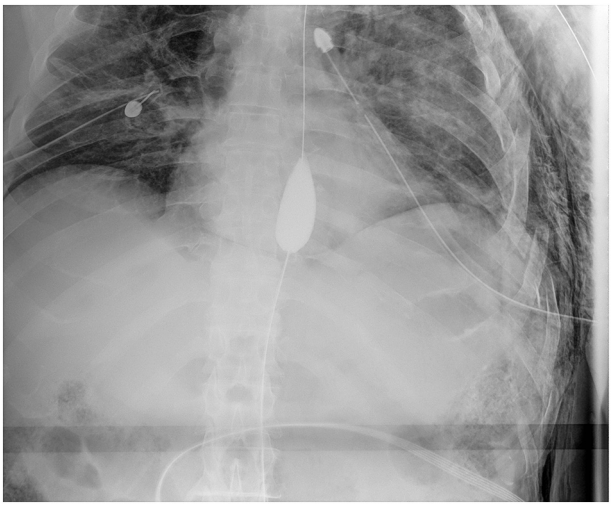

Fig. 1. X-ray showing resuscitative endovascular balloon occlusion (REBOA) inserted in zone 1.

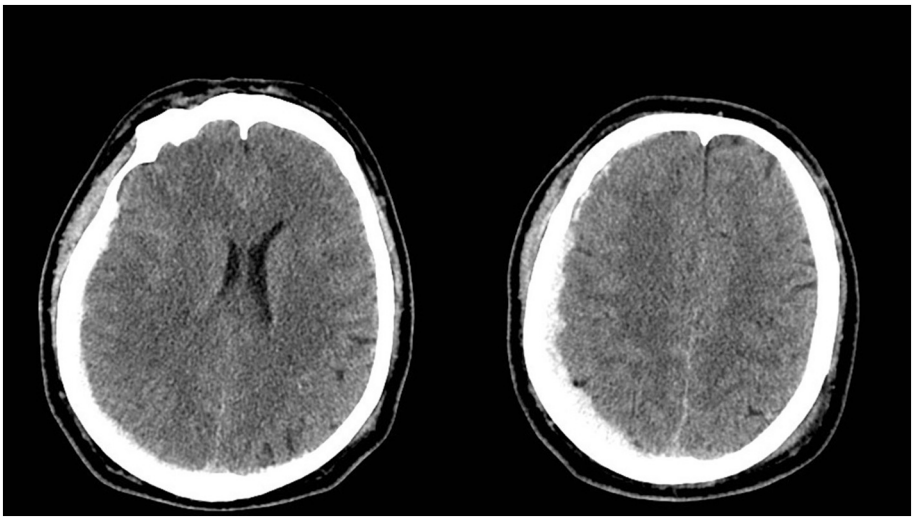

Fig. 2. Head CT scan showing right subdural hematoma with midline shift.

patients with severe trauma and reduced deaths by exsanguination [9]. Moreover, the same group found that the use of the hybrid emergency room is associated with the reduction of unfavorable outcomes in patients with severe TBI, allowing a reduction in time required for diagnosis and intracranial surgery [10].

In our context, the possibility of performing a brain CT in this selected kind of patients is often impossible and procrastinated to the end of the DSC for bleeding control.

The use of REBOA to manage haemorrhage is well described and is associated with improvement in the outcome of patients with torso injuries. Main complications described are ischemia, vessel ruptures, and vascular thrombosis [11].

Its use in patients with concomitant TBI has been questioned because of the risk of a worsening of intracranial bleeding due to the increasing of the carotid flow and pressure. In an animal model of TBI and shock, REBOA increased the carotid flow and SBP but did not exacerbate TBI progression [12]. In the same study, massive transfusion was associated with the largest fluctuations of cerebral physiology variables, maybe related to important increases in CVP.

In our opinion REBOA placement is a safe procedure in a shocked patient where the treatment goals are to obtain a SBP improvement and a bleeding reduction, thus preserving cerebral perfusion pressure and reducing the impact of secondary brain damage [13].

In conclusion, knowing that the duration of cerebral herniation is associated with worse outcomes and increased mortality [8], the achievement of a rapid brain CT scan is fundamental and has a profound impact in changing surgical management, allowing concomitant brain decompression during DCS. In this selected case we obtained the brain CT with the use of a REBOA, which allowed us to gain time to go to the CT room in safe conditions.

Our approach is far from being the best one but is feasible, not time-consuming and quite safe, thinking at the kind of patients it is intended for.

Abbreviations

TBI	Traumatic Brain Injury
SBP	Systolic Blood Pressure
WBCT	Whole Body CT-scan
REBOA	Resuscitative Endovascular Baloon Occlusive
DCS	Damage Control Surgery

Availability of data and materials

Not applicable.

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Ethics approval and consent to participate

Not applicable.

Consent for publication

An informed consent for publishing the abovementioned data has been obtained in oral form by the patient.

CRediT authorship contribution statement

LB, EG and ER took care of patient in the Emergency Room and ICU and wrote and revised the paper. LV, CB, GB and VA revised the manuscript providing intellectual content.

Declaration of competing interest

The authors declare they have no competing interests.

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