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Clinical paper

Major traumatic complications after out-of-hospital cardiac arrest: Insights from the Parisian registry☆

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ABSTRACT

Aim: Due to collapse and cardiopulmonary resuscitation (CPR) maneuvers, major traumatic injuries may complicate the course of resuscitation for out-of-hospital cardiac arrest patients (OHCA). Our goals were to assess the prevalence of these injuries, to describe their characteristics and to identify predictive factors.
Methods: We conducted an observational study over a 9-year period (2007–2015) in a French cardiac arrest (CA) center. All non-traumatic OHCA patients admitted alive in the ICU were studied. Major injuries identified were ranked using a functional two-level scale of severity (life-threatening or consequential) and were classified as CPR-related injuries or collapse-related injuries, depending of the predominant mechanism. Factors associated with occurrence of a CPR-related injury and ICU survival were identified using multivariable logistic regression.
Results: A major traumatic injury following OHCA was observed in 91/1310 patients (6.9%, 95%CI: 5.6, 8.3%), and was classified as a life-threatening injury in 36% of cases. The traumatic injury was considered as contributing to the death in 19 (21%) cases. Injuries were related to CPR maneuvers in 65 patients (5.0%, (95%CI: 3.8, 6.1%)). In multivariable analysis, age [OR 1.02; 95%CI (1.00, 1.04); $p = 0.01$], male gender [OR 0.53; 95%CI (0.31, 0.91); $p = 0.02$] and CA occurring at home [OR 0.54; 95%CI (0.31, 0.92); $p = 0.02$] were significantly associated with the occurrence of a CPR-related injury. CPR-related injuries were not associated with the ICU survival [OR 0.69; 95%CI (0.36, 1.33); $p = 0.27$].
Conclusions: Major traumatic injuries are common after cardiopulmonary resuscitation. Further studies are necessary to evaluate the interest of a systematic traumatic check-up in resuscitated OHCA patients in order to detect these injuries.

Introduction

Since their first descriptions during the 19th century [1], chest compressions have become one of the cornerstones of cardiopulmonary resuscitation (CPR). Practices have considerably improved over the years, such as the recent development of mechanical chest compression devices. Cardiac arrest (CA) of non-traumatic origin may be complicated by traumatic injuries [2], resulting from the loss of consciousness (i.e. sudden drop and collapse) or from CPR itself (especially because of chest compressions). Several studies and reviews have described traumatic complications that may be observed after CPR [2–17]. However, these studies were very heterogeneous regarding their design, some of these investigations focusing only on chest wall fractures (which are common but harmless) [3,6,14,15,17,18], others on an anatomic region or a specific organ [4,8,11,16]. Finally several authors reported post-mortem [3,13,16,17] or radiological [11,14,15,18] findings in non-survivors. Data are scarce regarding diagnosis and clinical impact of traumatic injuries diagnosed in a broad population of out-of-hospital cardiac arrest (OHCA) patients with return of spontaneous circulation (ROSC) [8,9,14,15].

Therefore, our main goal was to assess the prevalence of major traumatic complications in a large cohort of patients who received CPR maneuvers for an OHCA. Secondary goals were to identify potential risk factors for CPR-related injuries and to evaluate the impact of these CPR-

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related injuries on outcome.

Methods

Study design and population

During a 9-year period (January, 1st 2007 to December, 31th 2015), all consecutive patients admitted to a cardiac arrest center (Cochin University Hospital, Paris, France) after a non-traumatic OHCA were included in the study. OHCA patients who were declared dead on the scene or at hospital arrival were not included in the present study, as well as cardiac arrest due to trauma. The Ethics Committee of the French Intensive Care Society approved this observational study.

Patient management

Prehospital management

Management of OHCA in Paris and close suburb by emergency medical service (EMS) involves both a first-tier responder team (first-aid or fire department teams) and an emergency medical team (including at least one trained emergency physician). On witnessed call, both are dispatched on the scene. The first-tier responder usually arrives first and starts basic life support (BLS), including CPR and defibrillation with automated external defibrillator if indicated. On arrival, the medical team delivers advanced life support (ALS). Both BLS and ALS are performed in accordance with international guidelines [19]. During the study period, active compression-decompression CPR (ACD-CPR) was routinely used by the first-tier responders of the fire department whereas automated mechanical chest compression devices were not routinely used.

In-hospital management

OHCA patients in whom a sustainable ROSC is achieved are directly referred to our tertiary ICU, which is recognized as a "cardiac arrest center". Patient management after ICU admission is fully standardized, in accordance with international guidelines, and is summarized in the Electronic Supplementary Material (ESM) [20]. Specifically, an early diagnosis check-up, including a coronary angiography and/or a contrast-enhanced CT-scan is routinely performed, as previously described (Fig. 1) [21].

Data collection and definitions

All data related to the CA, ICU management and outcome were extracted from the French Parisian database, in which data are prospectively collected according to the Utstein style [22]. This database was previously described and received approval from the French data protection authority (CNIL) [21]. Each medical computerized chart was reviewed by two investigators (PAH and BC) in order to identify major trauma injuries diagnosed during the ICU stay, using a predefined list of categorized trauma (Table S1, ESM). For abdominal trauma, severity of injury was assessed using the American Association for the Surgery of Trauma (AAST) injury scale [23]. In agreement with a previous study [24], an identified intracranial bleeding was considered as resulting from a traumatic complication of CA only if a non-cerebral etiology of OHCA was formally identified and if this intra-cranial bleeding was not considered as the primary cause of the arrest, based on consensus between experts.

As previously described [8,9,13], all major traumas identified were defined and classified using a functional two-level scale of severity as *life-threatening* (i.e., reasonably expected to interfere with cardiovascular or respiratory function to the extent of depriving tissue of needed blood or oxygen; exsanguination in excess of 800 mL) or *consequential* (i.e., requiring therapy for repair or for alleviation of pain, expected to prolong hospitalization). Insignificant or minor traumas (i.e. requiring no therapy or potentially requiring limited one-time only therapy) were only recorded if specified in the medical report. Chest wall fractures (single or multiple rib fractures including flail chest and sternal fracture) were recorded only if there were classified as *life-threatening* or *consequential* injuries, as previously defined. Other collected data included: supposed mechanism of trauma (classified as secondary to CPR maneuvers: *CPR-related injury* or as secondary to the collapse and drop induced by CA: *collapse-related injury*), injury diagnosis method (classified as clinical diagnosis, casual diagnosis on the early etiological CT-

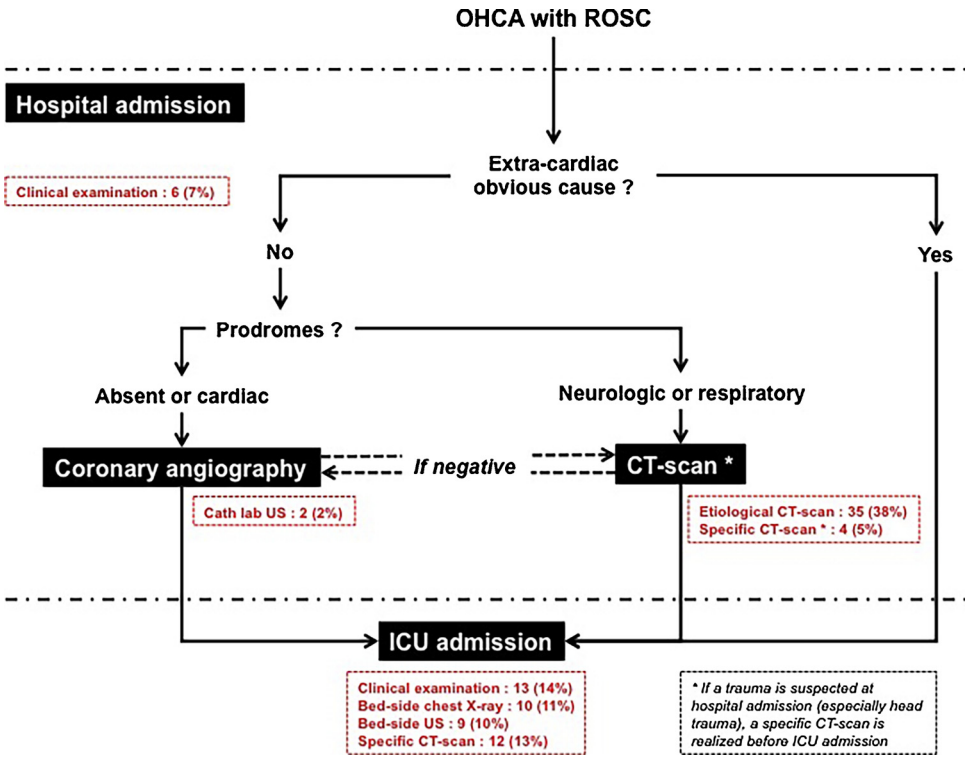

Fig. 1. Early diagnosis algorithm. Method and timing of injuries detection during the process are notified in the red dashed box (number of patients and percentage). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; ICU, intensive care unit; CT, computed tomography; US, ultrasound.