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Clinical paper

Conduction disorders in bradyasystolic out-of-hospital cardiac arrest☆

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ABSTRACT

Aims: Bradyasystolic heart rhythms are often recorded in out-of-hospital cardiac arrest (OHCA). Atrioventricular (AV) conduction disorders might lead to OHCA, but the prevalence of AV-conduction disorders and other bradyasystolic rhythms in OHCA is unknown. These patients might benefit from pre-hospital pacing. We aimed to determine the prevalence of different types of bradyasystolic heart rhythms in OHCA, including third degree AV-block, and document survival rates.

Methods: We used data from the ARREST-registry of OHCA in the Netherlands. Patients with bradyasystolic OHCA in 2006–2012 were included. ECGs were classified according to the presence of P-waves and QRS complexes in five rhythm groups. Differences in survival to discharge in relation to resuscitation characteristics, rhythm and pacing were tested using Chi-Square test and multivariate regression analysis.

Results: We included 2333 patients with a bradyasystolic rhythm; 371 patients (16%) presented with a third degree AV-block. In total 45 patients (1.9%, 95%-CI 1.4–2.5%) survived. A third degree AV-block (adjusted OR 0.86, 95%-CI 0.38–1.96) or pacing (adjusted OR 0.89, 95%-CI 0.21–3.78) was not associated with survival. Pacing was initiated in 110 patients (4.7%), after a long delay (median 18.7 min). The strongest association with survival was found for the presence of a bradycardia (vs. asystole) (adjusted OR 4.20, 95%-CI 1.79–9.83), bystander witnessed (OR 4.13, 95%-CI 1.45–11.8) and EMS witnessed collapse (OR 5.18, 95%-CI 2.77–9.67).

Conclusion: In bradyasystolic OHCA, 16% of all patients present with third degree AV-block, but survival for these and other bradyasystolic patients remains poor. Pacing is seldom initiated, often delayed, and rarely beneficial.

Introduction

In the last decades, the incidence of non-shockable heart rhythms (asystole or pulseless electrical activity [PEA]) as initial recorded rhythm in out-of-hospital cardiac arrest (OHCA) increased.[1,2] The prognosis of survival of patients with a non-shockable heart rhythm remains very poor, with survival to discharge rates not exceeding 3% for asystole and 10% for PEA, without a tendency to improve over years.[3–8] Non-shockable rhythms consist of multiple different rhythms such as sinus bradycardia, junctional/idioventricular rhythms, third degree atrioventricular (AV)-block or asystole. Most of these rhythms are of bradyasystolic origin, a ventricular rate below 60 beats per minute or asystole.[9] Despite their heterogeneous origin, all non-shockable rhythms are managed with one treatment algorithm with limited effect on survival, if no treatable causes can be identified. Generally, no other treatment besides high quality cardiopulmonary resuscitation (CPR), administration of intravenous vasopressors and transcutaneous pacing is available for these patients.

In a non-OHCA setting a symptomatic third degree AV-block is a Class I indication for pacing,[10] but it is unknown if patients in true cardiac arrest caused by a third degree AV-block will benefit equally from pacing. Current evidence suggests that in OHCA pacing by any means (transcutaneous, transvenous or transmyocardial) does not improve short- or long-term survival, and since 2005 resuscitation guidelines do not encourage pacing for routine use in OHCA.[11,12] However, it is not clear if different origins of bradyasystole, such as a third degree AV-block, have been identified in studies investigating pacing in OHCA.

The prevalence of the various different bradyasystolic heart rhythms is unknown. As an increasing number of non-shockable OHCA cases are observed worldwide, it is important to identify

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the electrocardiographically different rhythms, and to know their associated outcomes. We aimed to determine the prevalence of these bradyasystolic heart rhythms in a large cohort of consecutive OHCA patients, with an emphasis on identifying patients with AV-conduction disorders, and document the current resuscitation treatment practice and outcomes in these patients. We hypothesize that AV-conduction disorders are relatively common, but that pacing is often not initiated and is not associated with better survival.

Methods

Study design and setting

ARREST is an ongoing prospective registry of all consecutive resuscitation attempts in North-Holland, the Netherlands (population 2.4 million). The organization of the emergency medical services (EMS) and data collection in the study region has been described previously.[13] In short, for all suspected OHCA, two ambulances of a single tier are dispatched with defibrillators, all of which have pacing capability. Also, in a large part of the study region first responders (policemen, fire fighters and local lay rescuers[14]) equipped with an automated external defibrillator (AED) are dispatched in case of a suspected OHCA. On-site AEDs are available and used in an increasing number of public places. The present study is a retrospective analysis of electrocardiographic data gathered in the ARREST study.

Selection of patients

The present investigation covered the period January 1, 2006–December 31, 2012. All patients on whom EMS personnel attempted resuscitation during OHCA with an electrocardiogram (ECG) documenting an initial bradyasystolic heart rhythm were included in the study. We excluded patients with a clear non-cardiac cause (e.g. trauma, drowning, respiratory, neurologic, suicide), patients of whom the resuscitation ECG could not be retrieved or with an inconclusive ECG, patients with unknown survival status and patients with a paced rhythm before cardiac arrest.

The Medical Ethics Review Board of the Academic Medical Center, Amsterdam, approved the ARREST data collection and gave a waiver for obtaining (written) informed consent.

Data collection and definitions

Data of 7925 EMS-attended OHCA cases was retrieved from dispatch centers, EMS personnel, first responders and hospital case files. All data was collected according to Utstein recommendations.[15] All ambulance recordings of continuous single and 12-lead ECGs were digitally sent to the study center. If an AED was used, ARREST study personnel collected the stored continuous single lead ECG from the AED shortly after the resuscitation attempt. All manual defibrillator and AED clock times were synchronized to the dispatch center clock. The time stamp of EMS call and time of initial recorded rhythm from manual defibrillator or AED was used to calculate call-to-ECG delay.

In ARREST, the initial recorded rhythms of all ECGs from the AED or manual defibrillator, whichever was connected first, are categorized shortly after the OHCA by experienced research personnel in ventricular fibrillation (VF)/ventricular tachycardia(VT), supraventricular tachycardia, normal rhythm (frequency 60–100), bradycardia (defined as a ventricular rate of less than 60 beats per minute), asystole or undetermined rhythm. For the current analysis, all ECGs were reassessed by two researchers (M.H. and H.M) for the presence of p-waves, QRS complexes (with rate and QRS duration noted) and AV-conduction disorders (first, second and third degree AV-block). In case of disagreement, the rhythm was also interpreted by RWK to reach consensus. The presence of rapid irregular peak-to-peak baseline deviations of less than 100 μV (not related to deviations in the impedance signal) was considered secondary asystole (following VF dissolution).[16] ECGs were classified in five different rhythm groups: asystole (absence of p-waves and QRS complexes and no or less than <100 μV baseline deviations), third degree AV-block without escape rhythm, third degree AV-block with escape rhythm, idioventricular/junctional rhythm and sinus bradycardia (Fig. 1). When EMS personnel initiated pacing, the rhythm immediately preceding pacing and the occurrence of electrical capture was also noted.

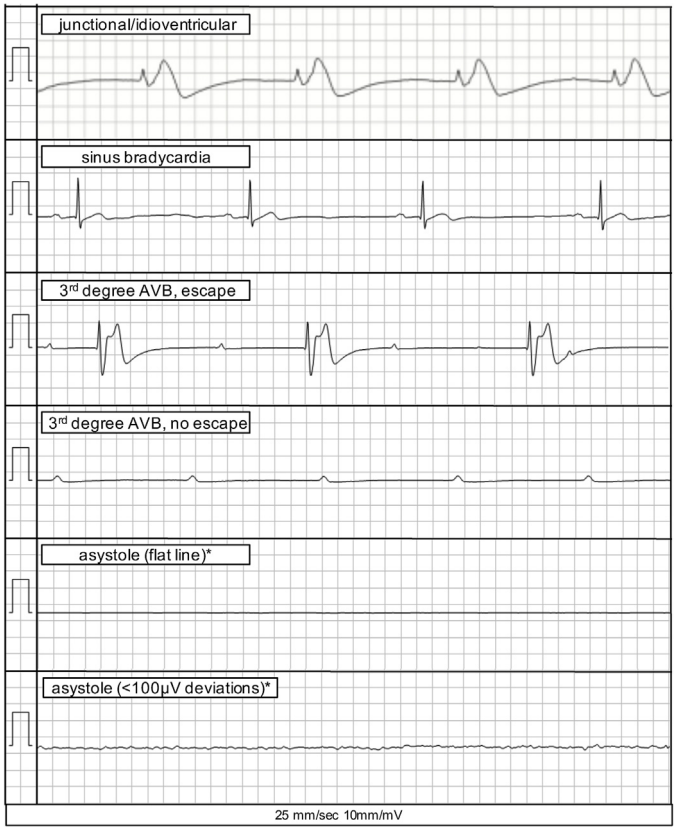

Fig. 1. illustration of ECG classification of all bradyasystolic rhythms. AVB denotes atrioventricular block. *Flat line and <100 μV baseline deviations are combined in one group, 'asystole'. This rhythm is defined as absence of p-waves and QRS complexes and no or less than <100 μV baseline deviations.

Neurological status at discharge was reviewed by research personnel from hospital patient charts using the Cerebral Performance Category (CPC) scale.[15] A CPC score of 1 (normal cerebral performance) or 2 (moderate cerebral disability) at discharge was considered as survival with a favorable neurologic outcome.

Statistical analysis

Normally distributed continuous variables were presented as mean ± standard deviation (SD) and differences tested for significance with Student's *t*-test and ANOVA. Time intervals were presented as median with interquartile range (IQR), differences tested using Mann–Whitney *U* and Kruskall–Wallis test. Differences between proportions were tested with Chi-Square test. Survival rates of the different rhythm groups were expressed as proportions with 95% confidence intervals (CI). Survival differences associated with demographic and resuscitation characteristics were calculated using logistic regression analysis, expressed as unadjusted odds ratio (OR) with 95%-CI. Survival differences in