Trauma Associated with Cardiac Conduction Abnormalities: Population-Based Perspective, Mechanism and Review of Literature

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Abstract
Objectives: Various cardiac conduction abnormalities have been described as being a result of trauma in many case reports. The aim of this research was to look at the association between trauma (thoracic and cardiac) and conduction abnormalities in a large hospitalized population.

Methods: Cases diagnosed with trauma and various cardiac conduction disorders were identified based on ICD-9-CM discharge diagnoses from 986 acute general hospitals across 33 states in 2001.

Results: Independent of potential confounding factors, discharge for blunt cardiac injury (BCI) was associated with a threefold increased risk for cardiac conduction abnormalities (95% confidence interval 2.45–4.51) during hospitalization in 2001. Both BCI and thoracic trauma had a significant association with right bundle branch block (RBBB) in this study (OR 6.04; 95% confidence interval (CI) 3.77–9.67 and OR 1.75; 95% CI 1.38–2.23 respectively).

Conclusions: The results of this study demonstrate the impact of trauma on cardiac conduction abnormalities. This study represents an attempt to consider a mechanism of a complex traumatic cardiac event from a population-based perspective, and may improve the prognosis for patients diagnosed with cardiac or thoracic injuries.

Key Words
Trauma · Conduction disorders · Mechanism of trauma

Introduction
Cardiovascular trauma is the second leading cause of death after central nervous system injury [1]. The true incidence of cardiovascular trauma is unknown because there is no standard diagnostic approach that would fully evaluate this condition [2, 3]. In addition, in some patients, cardiovascular trauma could be asymptomatic, which makes it difficult to diagnose [2].

Several case reports have described various cardiac conduction abnormalities such as complete atrioventricular block and left bundle branch block that occurred after the episode of trauma [4–9]. Other conduction abnormalities such as right bundle branch or bifascicular blocks have been also reported in the literature [10–14]. The interpretation of these studies, because of their design, could be limited due to confounding and bias.

The objective of this large population-based study, therefore, is to determine whether hospitalized trauma is related to an increased risk of cardiac conduction abnormalities, as well as to characterize the mechanism of such a relationship. Data from the population-based Healthcare Cost and Utilization Project are utilized for this investigation.

Methods
Inpatient data were derived from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample. The Nationwide Inpatient Sample (NIS) contains a national all-payer data set with 7.45 million uniform hospital discharge abstracts for all inpatient stays in 2001. A detailed description of the data is available at
The important feature of the NIS is availability of ICD-9-CM diagnosis codes. Other variables of interest include types and sources of admissions, primary and secondary sources of payment, and various patient-level characteristics. Body part groupings were based on one of the versions of the Barell matrix suggested by Barell et al. [15]. Thoracic trauma was identified based on the ICD-9-CM diagnostic codes 807.0–807.4; 839.61–839.71; 848.3; 848.4; 860–862; 875; 879.0; 879.1; 901; 927.0; 922.1 and 942.x1–942.x2. Blunt cardiac injury (BCI) was identified based on ICD-9-CM diagnostic code 861.0.

As mentioned earlier, case reports have identified several conduction abnormalities resulting from trauma. On the one hand, the transient character of certain traumatic conduction abnormalities as well as a limited diagnostic work-up in the case of less severe injuries could lead to potentially missed traumatic conduction events. On the other hand, traumatic cardiac conduction abnormalities are rare. Therefore, they have all been combined into one outcome based on ICD-9-CM 426, so that all relevant outcomes have been identified. However, for the mechanism-related considerations, right bundle branch block (RBBB) has been identified based on ICD-9-CM 426.4 as well.

Cases have been examined by patient age, gender, length of hospital stay, primary source of payment and presence of conduction abnormalities. Consistent with previous studies, length of stay was categorized as a categorical variable (3 days or less versus more than 3 days) [2]. Primary source of payment included Medicare, Medicaid and other [including private (including HMO), self-pay and no charge]. Data analyses were conducted using SPSS for Windows (version 12.0; SPSS, Chicago, IL, USA.)

Results
Based on discharge ICD-9 coding methodology, it was calculated that there were 7,452,727 discharges in total, of whom 965 (0.01%) of the patients had BCI, 17,150 (0.23%) had thoracic injuries and 107,102 (1.44%) had cardiac conduction abnormalities. Of the 107,102 patients with conduction disorders, 21,443 (20.02%) were diagnosed with RBBB. Of the 107,102 patients with conduction disorders, 21,443 (20.02%) were diagnosed with RBBB. There were 68 patients or 0.4% of the total (68 out of 17,150) who had both chest trauma and RBBB. Of these, 62 (91.2%) did not have a code for cardiac injury. Of the 965 patients who suffered from BCI, 732 (75.9%) did not have chest trauma. The proportion of RBBB among all patients (0.30%) was lower than the proportion of RBBB among patients with BCI (1.90%), and this difference was statistically significant ($\chi^2 = 83.72; df = 2; p < 0.0001$). The proportion of RBBB among all patients (0.30%) was lower than the proportion of RBBB among patients with thoracic trauma (0.39%), and this difference was statistically significant ($\chi^2 = 7.09; df = 2; p < 0.05$).

Table 1 and 2 show social, demographic and hospital-related characteristics of patients with BCI and thoracic trauma. Patients with BCI were older, more likely to be female and more likely to stay longer in the hospital compared to patients with thoracic trauma. There were more cardiac conduction abnormalities and RBBB among patients with BCI compared to those with thoracic trauma (4.7% vs. 1.0% and 1.9% vs. 0.4%, respectively).

After controlling for potentially confounding factors, including age, sex, race, length of stay and source of payment, patients with BCI were 3.33 times more likely to have cardiac conduction abnormalities (95% confidence interval 2.45–4.51) during hospitalization in 2001. There was no statistically significant association between thoracic trauma and conduction abnormalities in this study. At the same time, patients diagnosed with BCI were 6 times more likely to have RBBB in the adjusted analysis (95% confidence interval 3.77–9.67). An increased risk for RBBB was also observed among patients with thoracic trauma (OR 1.75, 95% confidence interval 1.38–2.23).

Discussion
Many forms of cardiac trauma have been identified through clinical case reports, such as pericardial injury...